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DOCUMENTATION AND USER'S MANUAL FOR THE VISUAL DETECTION SIMULATOR (VDS)

Julie A. Hopson

April 1979

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA FLORIDA

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Visual Detection Simulator (VDS) is comprised of three individual subsystems: A Link GAT-1 trainer, a projection system, and a PDP 8/e controller. These systems have been custom interfaced to permit the study of target acquisition in a simulated in-flight environment. The purpose of this report is to provide an operational and maintenance manual for the VDS system. Subsystems and their interrelationships are described, and operational procedures for the total system are provided. Computer programs for the simulator operation, data transfer, and the maintenance, and testing procedures are included.

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SUMMARY PAGE

THE PROBLEM

The Visual Detection Simulator (VDS) is comprised of three individual subsystems: a Link GAT-1 trainer, a projection system, and a PDP 8/e controller. These systems have been custom interfaced to permit the study of target acquisition in a simulated in-flight environment. The purpose of this report is to provide an operational and maintenance manual for the VDS system.

FINDINGS

Subsystems and their interrelationships are described, and operational procedures for the total system are provided. Computer programs for the simulator operation, data transfer, and maintenance checks are included. Slides are arranged and catalogued, and calibration, maintenance, and testing procedures are provided.

ACKNOWLEDGMENTS

The technical assistance of TDC Frank Hall (Naval Technical Training Center), John Cotsonis and Herb Cring (Singer-Link) regarding the GAT-1 are greatly appreciated. Special thanks go to Mr. Bernie Patton (Transportation System Center) and Efrain Molina (NAMRL) for their assistance regarding modifications required by the VDS system, troubleshooting problems, and testing procedures.

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GENERAL DESCRIPTION

The Visual Detection Simulator (VDS) permits the study of target acquisition in a simulated in-flight environment. The main components of the system are a series of projectors that recreate a flight scene spanning a wide visual field, a Link GAT-1 trainer, a PDP-8/e computer, and a supervisor control station. Photographs included in this section pictorially illustrate the integration of the major subsystems.

The GAT-1 trainer is located in the center of the spherical projection screen, which covers 176^{o} in azimuth and 25^{o} in elevation. The screen has a directional gain of about 10 with an average brightness of 200 ft.-L when illuminated with an open projector slide gate. The pilot's eye position in the GAT-1 trainer is 4.57 meters (15 feet) from the screen and one foot below its center of curvature. The angular resolution of the projector system with respect to this position is better than 1 minute of arc.

Behind the GAT-1 is a projection booth, which is elevated to provide a clear line of sight for a series of 28 Kodak Ektagraphic slide projectors. To minimize any adverse effects from heat and dust to the slides, the booth has an air conditioning system that maintains positive pressure within the booth and the air is electrostatically filtered. A pair of slide projectors is allotted to each screen sector. Each pair is controlled by a dedicated Dissolve Unit to successively select alternate projectors, advance slide trays, and maintain constant screen illumination. The projectors, located 25 feet from the screen, are used to present a series of scenes of aerial photographs. With the combination of real-world slides, screen brightness, and the photographic resolution of the colored slides, the outside world is protrayed with a good degree of realism.

The GAT-1 is a flight and navigational trainer, which includes a sophisticated solid-state analog flight computer, motion and sound simulation systems, a full complement of operational flight and engine instruments, and provisions for the reception of simulated navigational systems. Electronically computed atmospheric, ground, and aerodynamic effects enables the trainer to respond realistically to all pilot controls. An input panel to the navigational computer has been developed so that station locations, identification, and frequencies can be readily programmed. The utilization of these devices provides realistic flight conditions and workload in the VDS system.

A mini-computer exercises real-time control of the projection system, records target-acquisition data, and monitors flight performance by sampling altitude, rate of altitude change, airspeed, heading, and VOR deviation at specified intervals. Comparison of actual flight performance and requested maneuvers are logged for the various detection conditions. Figure-of-merit values for the flight data and the detection scores are automatically summarized at the end of an experimental run.

Flight paramerters that serve as referents for calculating the figure-of-merit value can be set at the Supervisor's Console. The Supervisor's Console is multifunctional. A panel of flight-repeater gauges allows monitoring of the pilot's flight performance. Flight characteristics of the GAT-1 can be altered by changing environmental factors such as turbulence, wind direction, and wind velocity. In addition to these controls, there is a communication system that enables the supervisor to act as an air-traffic controller.

When the system is fully integrated, a pilot flies a predetermined flight plan and views the changing surround in order to detect other aircraft in the visual field. When an aircraft has been detected, the pilot depresses a button located on the yoke and announces to the "air traffic controller" the screen sector in which the target appears. The supervisor depresses the corresponding sector button, thus logging that response.

During the flight, the supervisor monitors the flight conditions and flight plan. When a pilot does not follow his assigned flight procedures, the supervisor takes the appropriate steps to see that the pilot corrects his error and that the corrective action is not included in the calculations of the performance measures. The supervisor also continually updates the reference "command" flight parameters used by the computer program and alters workload by either increasing communication demands or changing the flight conditions.

Throughout the flight run, the computer controls the advancement of the slide projectors, records the detection data, and compares command flight parameters with actual real-time analog samples from the GAT-1. At the end of the flight, the data are summarized and printed out by the teletype.

Photographs of the Visual Detection Simulator are presented in Figures 1-1 1-2 and 1-3.

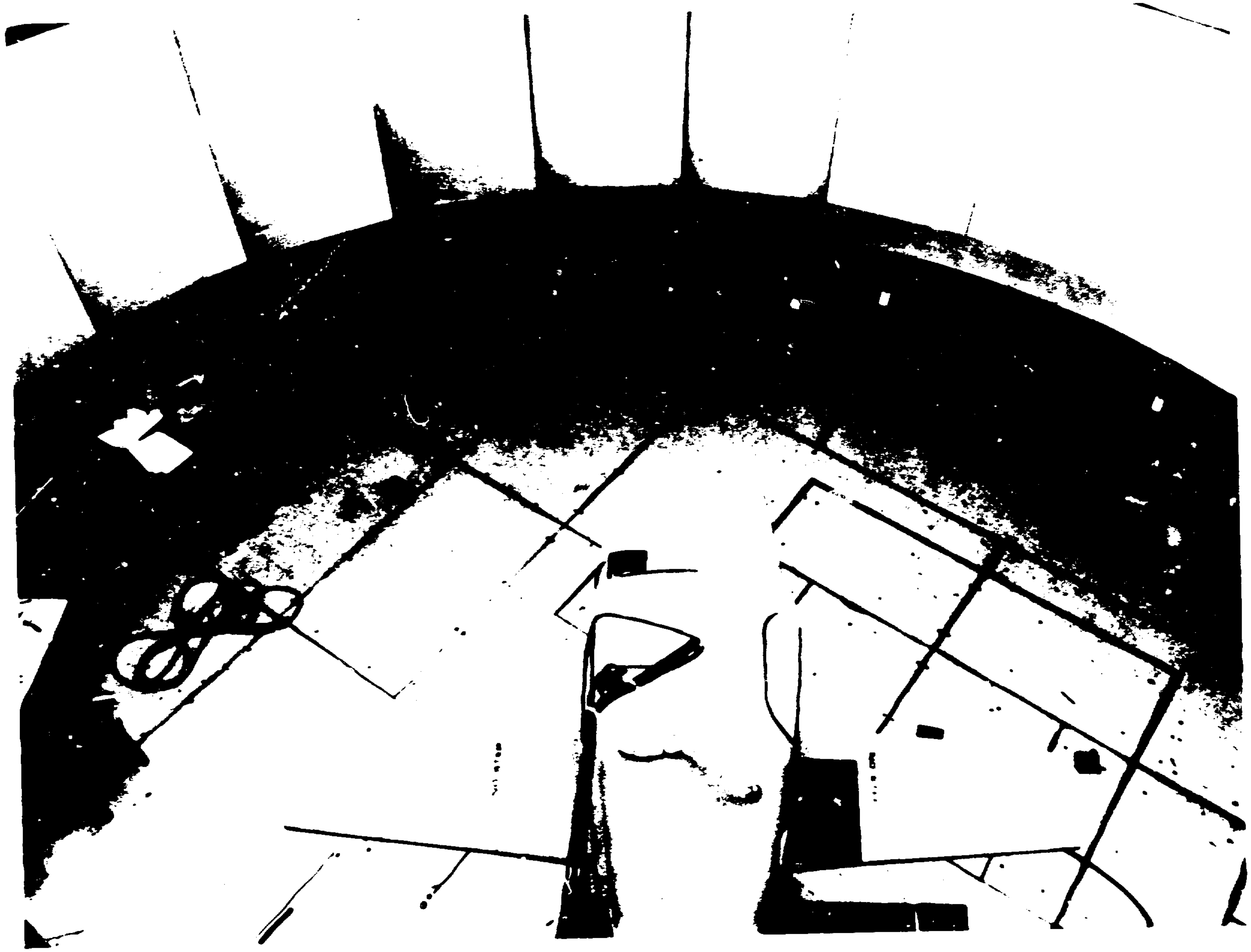


Figure 1-1. Visual Detection Simulator: GAT-1 and projection screen.

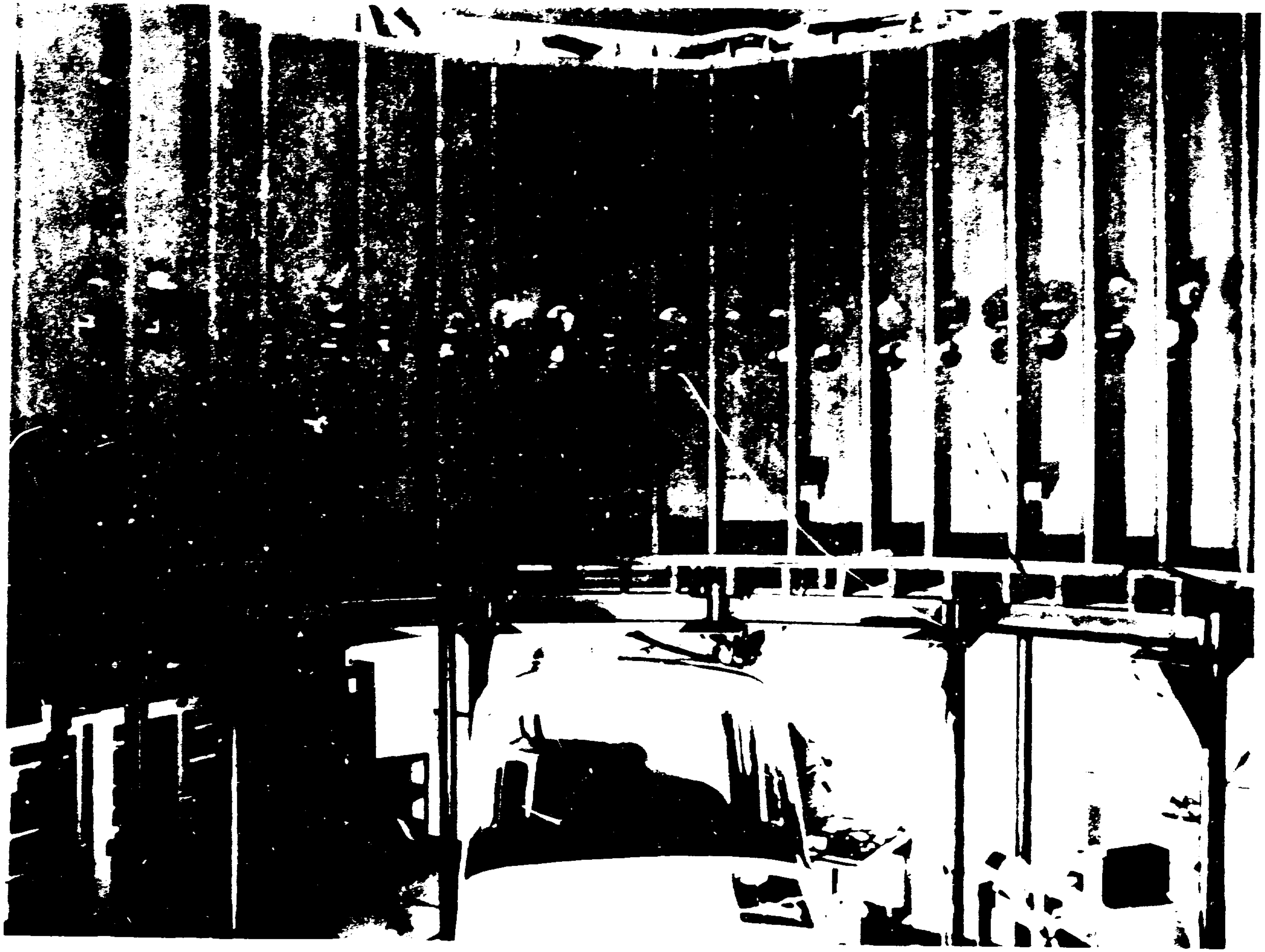


Figure 1-2. Visual Detection Simulator: GAT-1 and projector ports.

Figure 1.3. Projection Booth of the Visual Detection Simulator.

PHYSICAL HARDWARE DESCRIPTION

This section provides a brief description of each major hardware component used in the VDS system. More detailed treatment of these components and their interrelationships is provided in other sections of the manual.

A. PROJECTION SCREEN

The projection screen is an assembly of 28 separate sections individually mounted to a support structure. Each section is a standard 1.02 meter x 1.02 meter (40" x 40") Kodak Ektalite screen that has been carefully cut to a tapered width to obtain butt joints when mounted in a spherical configuration. The individual sections and the composite screen have spherical surfaces with a radius of 4.57 meters (15 feet) covering 176° in azimuth and 25° in elevation with respect to the focal point, the pilot's eye position in the GAT-1.

The total azimuthal field-of-view (FOV) is sub-divided into 14 sectors with each covering approximately 12.55°. Each sector includes two vertically stacked screens and is illuminated by a dedicated projector-pair that operates in an alternating sequence. All 14 sectors are filled with contiguous, projected images and provide a continuous panoramic view.

The important characteristics of the VDS screen stem from the directional gain of the Ektalite design. The gain with respect to a matte surface is approximately ten, which yields a ten-fold increase in brightness. The directional gain of the screen minimizes reflection of incident ambient light from angles outside the lobe. These factors permit viewing projected stimuli with full color saturation under high ambient lighting conditions.

B. PROJECTION BOOTH

All projectors, dissolve units, and slide trays are housed in an enclosed elevated projection booth behind the GAT-1. Environmental controls have been included in the booth for maximum protection of the equipment and slides. There is an air conditioner and a humidifier to control temperature and humidity. A combination of an electrostatic precipitator, filters, and a positive pressure differential are used to remove dust. An automatic washing machine within the booth permits periodic slide washing without the necessity of removing the slides from the trays.

C. PROJECTORS AND DISSOLVE UNITS

A dedicated pair of Kodak Ektagraphic 35 mm slide projectors illuminates a $12.55^{o} \times 20^{o}$ sector on each screen. The projectors provide precise vertical and horizontal slide positioning. A Dissolve Unit controls each projector pair by successively selecting alternate projectors, advancing slide trays, and maintaining constant screen illumination during projector switch-over. With 2 synchronously switched projectors per screen sector, 140 slides per tray, and a 10-second interval between slide presentation, the longest visual scenario is 47 minutes.

D. SLIDES

All photographic flights were made with seven motor-driven Nikon cameras boresighted for a contiguous field. Kodachrome II color film was used in order to maximize resolution and to minimize graininess. After processing, individual slide frames were cemented on specially selected glass with precise registration ±.127 millimeters (±.005 inches). The glass provided dimensional stability and maintained the entire frame in proper focus. Precise registration was essential to minimize and control gaps and overlaps along the edges of adjacent projected images on the screen.

In excess of 30,000 slides of aircraft in collision and near-miss encounters were produced in a previous photographic flight program at NAFEC for the original PWI experiment for the FAA. An experimental scenario requires 3920 slides (14 projector pairs with 140 slides per tray).

E. GAT-1

Simulated flight conditions and workloads are provided by the GAT-1 general aviation trainer manufactured by Link for flight and navigation training. It provides training in both contact and instrument flight skills for single engine light aircraft. The pilot's station is typical of the left seat arrangement of a two-place, side-by-side, light aircraft. Control and indicators are also typical of those found in light aircraft. The instructor's control panel, normally located on the right-hand side of the cockpit shell aft of the trainer door, has been relocated on the supervisor's panel for the VDS. An X–Y plotter recorder is linked to the trainer to provide a graphic record of the flight path during a simulated flight.

F. NAVIGATIONAL AREA PROGRAMMING PANEL

A navigational programming panel is located on the back of the Supervisor's Console with extended ribbon cable linking the modules to the appropriate circuit cards in the GAT-1. This panel consisting of potentiometers and plug-in patch panels has been developed for the VDS to allow ready programming of the simulated navigational systems. The panel has provisions to select two ILS, six VOR, and four ADF station frequencies, station calls, and station locations within a 120 nautical mile square area. This panel along with the X-Y plotter, provides the VDS system with the flexibility to change the navigational area to fit any flight plan necessary to meet experimental requirements.

G. MINICOMPUTER

A DEC PDP-8/e minicomputer controls the projection system, monitors flight parameters, computes a figure-of-merit for the quality of piloting, and records times of visual detection and target position reports by the pilot. The computer is a 12-bit machine equipped with 16K of core memory. Listed below is a brief description of the I/O devices and peripherals which are connected directly to the PDP-8/e omnibus.

1. Teletype, LT-33

This unit is a standard low-speed (10 character per second) ASR-33 teletype. A keyborad and paper tape reader are provided for computer inputs, and hard-copy outputs are available as coded holes on paper tape and as standard English text on continuous roll paper.

2. Paper Tape Reader

A fast paper tape reader (300 characters per second) is provided to reduce the time required to input pre-run data during VDS experiments. This unit is mounted in the PDP-8/e computer rack.

3. Digital I/Os

Six digital I/O modules are plugged into the omnibus in the main computer drawer. Each device provides 12 independent input and output bits. These devices form the interface between the computer and all external digital input and output devices. Typical signals include projection control and all switch inputs on the Supervisor's Console.

4. A/D Converter

An A/D converter and multiplexers are mounted at the top of the computer rack. These devices sample continuous analog signals from the GAT-1. Typical signals are roll, pitch, heading, altitude, altitude rate, and airspeed.

5. Real-Time Clock

A programmable real-time clock installed in the PDP-8/e generates the timing signals for VDS control.

H. SUPERVISOR'S CONSOLE

All experiments are run by a supervisor from a Supervisor's Console which includes input controls, output monitors, and reference displays. Rotary, toggle, and thumbwheel switches are provided to enter assigned heading, airspeed, and altitude into the computer which serves as reference values for calculating "piloting" figures-of-merit. Repeater aircraft instruments permit real-time monitoring of flight parameters by the supervisor. A microphone and headphone linkage with the trainer allows for communication between the supervisor and "pilot" and allows for simulated air traffic control during flight. The supervisor also has a running-time clock with Start, Stop, and Continue pushbutton controls for experimental runs.

I. JUNCTION BOX

External to the computer, all digital signal routing, processing, buffering, and switching are implemented in the Junction Box. All cables for distributing digital I/O signals between the computer and the Supervisor's Console, the GAT-1 displays, the pilot detect button, and the projection system either emanate from or terminate at the Junction Box.

VDS COMPUTER CONFIGURATION

I. GENERAL

The VDS is designed around a PDP-8/e minicomputer manufactured by Digital Equipment Corporation (DEC). Table 3-I lists VDS peripherals, options, and I/O devices which are also manufactured by DEC and are described in a series of DEC published handbooks, manuals, and brochures. Figure 3-1 illustrates the flow between the computer omnibus, standard peripherals, and I/O control devices.

The PDP-8/e is a 12-bit machine with 1.2 microsecond cycle time. The VDS configuration has 16K of memory to accommodate a large number of program instructions and floating-point arithmetic. A standard slow-speed (10 characters per second) teletype provides a keyboard input channel, a paper tape punch output, and hard-copy English text outputs. The VDS also includes a fast (300 characters per second) paper tape reader for program loading and real-time inputs.

VDS timing is controlled by a programmable real-time clock which is plugged into the PDP-8/e omnibus. Most VDS operations and I/O data transfers are programmed to take place on a fixed schedule. The clock generates time markers every 0.01 second, and a 24-bit word in memory is incremented by one count at each tick. This provides a maximum, unambiguous time base of 47 hours with an accuracy of 0.01 second.

Precise VDS time-keeping, at least for the duration of an experiment, is also required for recording detection times. In this case, the input is an unscheduled interrupt I/O transfer rather than a scheduled programmed transfer.

All digital data transfers in the VDS are made using digital I/O modules. Each of these devices provides 12-bit output and input channels. All inputs and outputs have negative T^2L logic levels; i.e., true signals are 0 volts and false signals are +5 volts. Jumpers are provided so that each input bit can be wired for level or edge detection, and for interrupt or programmed data transfer. In the VDS, START, STOP, SUSPEND, CONTINUE, DETECT, DETECT SECTORS (14), and DETECT ERROR inputs are jumpered for leading edge detection and interrupt. All other digital inputs are static "command" flight parameters which are jumpered for level detection and programmed sampling.

The computer regularly (every 5 seconds) compares these digital "command" flight parameters with actual real-time samples of GAT-1 analog signals. An analog-to-digital conversion system with signal multiplexers implements this sampling and conversion. Programmed addressing, gain control, and bipolar operation permit 10-bit conversions for a wide range of signal levels without external level set amplifiers and inverters.

Table 3-1

COMPUTER, PERIPHERALS, OPTIONS AND I/O's

ITEM	DEC MODEL	DESCRIPTION	USE IN VDS
Computer, 8K	PDP-8/e	Processor : 8K Memory, Programmers Console, Teletype Controller	VDS Control, Computation, and I/O
Core Memory (2)	MM8-E	Additional 8K Memory, 4K per each module	Required for Program Store & Floating-Point Arithmetic
Teletype	LT33-DC	Standard ASR-33 Teletype	Slow-Speed Output and Paper Tape Punch
Tape Reader	PR8-E	Fast Paper Tape Reader: 300 Characters per Second	Real-Time Transfer of Input Data from Mass Storage
Clock	DK8-EP	Programmable Real-Time Clock	VDS Timing
Digital I/O's (6)	DR8-EA	Buffered 12-Bit Digital I/O Channels	Input and Output Channels for Digital Signals
ADC System	AD01-AP	10-Bit Analog-to-Digital Converter	Sampling of GAT-1 Flight Parameters
Multiplexer (3)	A124	4 Channel Multiplexer Switches for A/D Convertor	Used with Converter
Bipolar Option	AH05	Modifies A/D Converter for Bipolar Operation	Sampling $\pm$ Signals

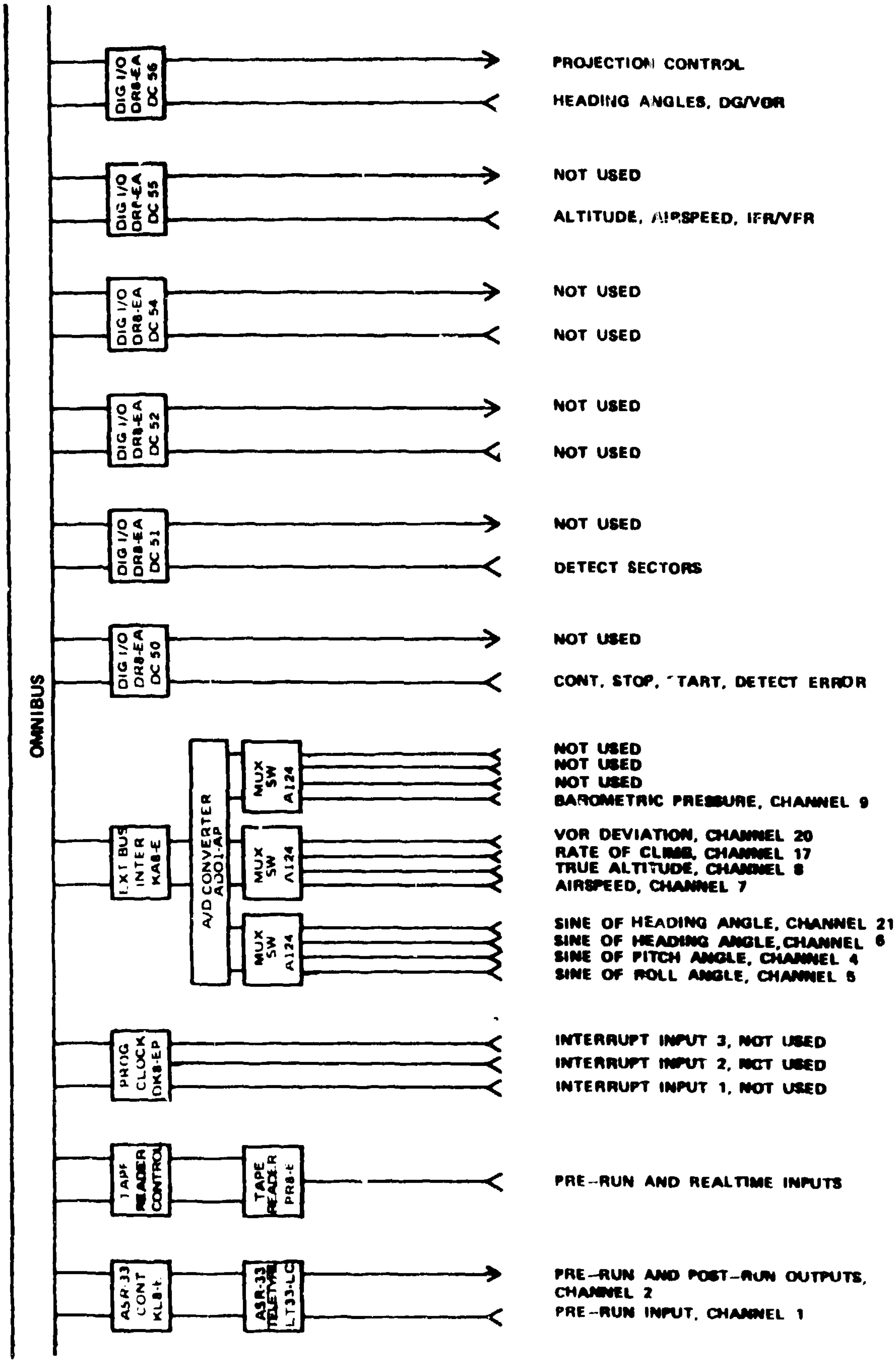


Figure 3-1. Computer I/O Interfaces

II. DIGITAL SIGNALS

Figure 3-2 shows all VDS digital signals at the computer digital I/O interface. Some knowledge of the Digital I/O Modules and the Junction Box is essential to understand the role of these signals in VDS operation. The essential features are described here. Note that all digital VDS signals pass through the Junction Box; i.e., all cables emanating from Digital I/Os terminate at the Junction Box. There are eight such cables and they connect to DC50(J2), DC51(J2), DC52(J1), DC54(J1), DC55(J1), DC55(J2), DC56(J1), and DC56(J2).

Each Digital I/O (DR8-EA) in the VDS provides physically separate 12-bit output (J1) and input (J2) channels. These devices are addressed by the computer according to the device codes (DC5X) indicated in Figure 3-2. Every bit position (0 through 11) can be treated as a separate I/O channel with independent computer control of data transfer. All output data are represented as standard but inverted T2L logic levels; i.e., +5 VDC is false and GND (0 VDC) is true. Input signals must also use this inverted logic. All input bit positions can be independently connected for (a) level or leading-edge detection, and (b) programmed or interrupt data transfer. Two sets of jumpers are available to implement selected options. Normally, leading-edge detection is used when one wishes to record the occurrence of short-term events, and level detection is used when one wishes to sample signal status. All inputs on DC50 and DC51 are wired for edge detection and interrupt data transfer. All inputs on DC55 and DC56 are jumpered for level detection and programmed data transfer.

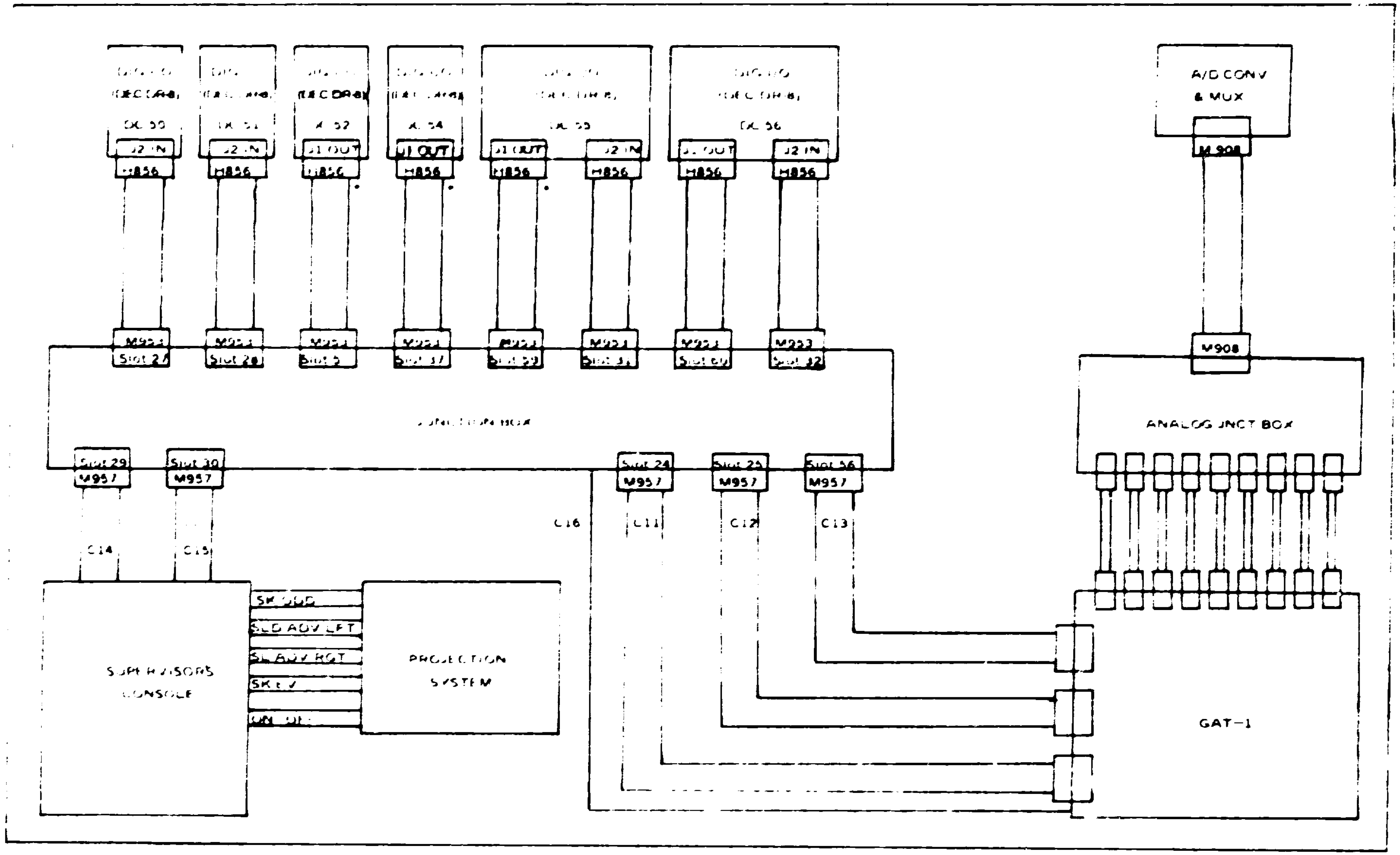
III. ANALOG SIGNALS

There are nine analog VDS inputs to the computer's analog-to-digital converter. The signals which originate from the GAT, to the computer, are as follows:

1. Sine of the roll angle
2. Sine of pitch angle
3. Sine of heading
4. Cosine of heading
5. Indicated airspeed
6. True altitude
7. Rate of climb
8. VOR deviation
9. Barometric pressure

Currently, the sine of the roll angle and sine of the pitch angle are not being monitored by the VDS system. The other signals are used to calculate figures-of-merit which allows for assessment of flight performance.

Table 3-II lists the source of the signals and briefly describes their characteristics. Details of these signals can be found in the manufacturer's literature.



* Not presently being used

Figure 3-2
VDS INTERCABLING AND CONNECTORS

Table 3-II

CHARACTERISTICS OF VDS ANALOG SIGNALS

SIGNAL	SOURCE OF SIGNAL IN GAT 1	SCALE OF SIGNAL	RANGE OF SIGNAL
SINE OF ROLL ANGLE	MOTION BASE	$V = 15 \sin \psi$ $\psi = \pm 12.5^\circ$	V: $\pm$ 14.5V
SINE OF PITCH ANGLE	MOTION BASE	$V = 15 \sin 2\theta$ $\theta = +20^\circ$ to -10°	V: + 9.64 to -5.13V
SINE OF HEADING	MOTION BASE	$V = 10 \sin \psi$ $\psi = 0^\circ$ to 360°	$\pm$ 10 VDC
COSINE OF HEADING	MOTION BASE	$V = -10 \cos \psi$ $\psi = 0^\circ$ to 360°	$\pm$ 10 VDC
AIRSPEED, INDICATED	RELATIVE WIND CARD	16 MPH/VDC	0 to -10VDC, 0 to 160 MPH
TRUE ALTITUDE	ALTITUDE CARD	1333.33 FT/VDC	0 to -15VDC, 0 to 20,000 Feet
RATE OF CLIMB	ALTITUDE CARD	-1 V per 250 FT/MIN. CLIMB +1 V per 250 FT/MIN DESCENT	$\pm$ 10 VDC
VOR DEVIATION	VOR/ILS CARD	+VDC FLY RGT -VDC FLY LFT	$\pm$ 10 VDC
BAROMETRIC PRESSURE	SUPERVISOR'S PANEL	61.33 FEET/VDC	$\pm$ 15 VDC, 29.00 to 31.00 INCHES OF MERCURY

IV. JUNCTION BOX

As noted earlier, all VDS digital computer input signals pass through the Junction Box on their way to DC50, DC51, DC55, and DC56 (DC52 and DC54 are not presently being used). For all of these signals the Junction Box simply provides multiplexing between input and output connectors for proper signal routing. For the output signals the Junction Box also provides logic, switches, and drivers. These Junction Box functions are: a) NOR gates for conversion from 10 x 10 lines to 100 lines; b) slide control signals, signal inversion, relay drivers, and relays; c) lamp drivers; d) drivers for tone oscillators; and e) a one shot for the detect button in the GAT.

The Junction Box is a simple assembly of eight connector blocks. Each block has 8 slots for 36 pin connectors on one side and 36 wire wrap pins on the opposite side. The entire assembly accommodates 64 modules.

V. SUPERVISOR'S CONSOLE

Located in the supervisor's panel are rotary, toggle, and thumbwheel switches which serve as input controls to provide assigned heading, airspeed, and altitude values to the computer. The pushbutton switches on the panel serve as digital input for designating the screen panel on which a target was detected and for controlling an experimental run. All switches connect directly to signal lines with no interface circuitry. The push button switches are normally open and momentarily short the signal line to ground when depressed. The other switches present a short to gound on "true" bit position.

Located on the main panel is a running clock with Stop, Start, and Reset controls. Although the clock is controlled by switches which are part of the computer system, it is governed by its own circuitry and has a separate ground.

VI. PROJECTION SYSTEM CONTROL

The Projection System includes 14 pairs of projectors with each pair being controlled by a dedicated Dissolve Unit. In real time these units are controlled by four control signals (SL ADV LFT, SL ADV RGT, SK EVEN, and SK ODD). SL ADV LFT controls slide advances of the 7 projector pairs which illuminate the left half of the projection screen. SL ADV RGT controls slide advances of the 7 projector pairs which illuminate the right half of the screen. SK EVEN controls slide skips in the 14 "even" projectors, and SK ODD controls slide skips in the alternate set of 14 "odd" projectors.

Relays in the Junction Box isolate the low level digital signals and computer ground lines from the projection system. All four signal inputs are relay closures which toggle a second set of relays in the Projection System.

VII. INTERCABLING

Figure 3-2 illustrates VDS intercabling and connectors. Table 3-III summarizes the same information.

Table 3-III

VDS SIGNAL CABLES

CABLE DESIGNATION	FROM	TO	DESCRIPTION	SIGNALS
C1	JB SLOT 27	DC 50-J2	DEC BC08J-10	START, STOP, CONT, DET ERR & DET SECTORS 13, 14, DET-GAT-1
C2	JB-SLOT 28	DC 51-J2	DEC BC08J-10	DETECT SECTORS 1-12
C3	DC 52-J1	JB SLOT 5	DEC BC08J-10	NOT USED
C4	DC 54-J1	JB-SLOT 37	DEC BC08J-10	NOT USED
C5	JB SLOT 31	DC 55-J2	DEC BC08J-10	AS 1-2 AND ALT 1-5
C6	DC 55-J1	JB-SLOT 59	DEC BC08J-10	NOT USED
C7	JB-SLOT 32	DC 56-J2	DEC BC08J-10	DG/VOR, BCD ANGLE, & LEVEL/CLIMB
C8	DC 56-J1	JB-SLOT 60	DEC BC08J-10	SL ADV, SL SKIP
C9	ANALOG JB	AD01-SLOT A19	DEC BC02X-6	GAT-1 ANALOG SIGNALS
C10	GAT-1	ANALOG JB	COAX CABLES (9)	GAT-1 ANALOG SIGNALS
C14	SUPER CONS	JB-SLOT 29	MULTIPLE COND	START, STOP, CONT, DET ERR, & DET SECTORS 1-14
C15	SUPER CONS & PROJ BOOTH	JB SLOT 30	MULTIPLE COND	AS, ALT, DG/VOR, BCD ANGLE, SL ADV, SL SKIP
C16	JB-SLOT 3	DET BUTTON IN GAT-1	COAX CABLE	PILOT DETECT

VDS COMPUTER PROGRAM

I. INTRODUCTION

A PDP 8/e mini-computer serves as a controller and real-time data analyzer for the VDS System. The main program and most of the subroutines are written in Digital Equipment Corporation (DEC) 8K Fortran, whereas, the input/output subroutines for the peripheral devices are written in SABR (Symbolic Assembler for Binary Relocatable Programs). In total the VDS program requires 16K of memory.

The VDS System was originally developed by the Federal Aviation Agency to assess the effectiveness of three display/alarm pilot warning instruments (PWI) in reducing the probability of mid-air collisions. Since most of the VDS computer program can be easily modified to meet research needs, the program has been left completely intact. At present, subroutines written specifically for the PWI (aural alarm, sector display, head-up display) are not currently being accessed. This is accomplished by setting the necessary parameters to zero on the paper tape input. The subroutines not being used are SCTR, AURAL, HDUP, and HUD (I,J).

The VDS computer program listing is included, and discussion of the use and purpose of each part of the program is presented below. Input, output, error messages, program loading, and data transfer to HP2100 are also described in this section.

II. MAIN PROGRAM

The main program reads the input (see Part V) from the Teletype (TTY) and the fast paper tape reader (PTR), and cycles through a closed loop, checking whether any of the peripherals have to be serviced. A simplified flow chart is shown in Figure 4-1.

The first subroutine called is the SABR subroutine INIT which sets the correct initial conditions. The SABR subroutine RPPT reads the PTR and deposits the information in the memory in an array IRAY. The Fortran subroutine DECOD decodes the information deposited in IRAY. The trial is started by pushing a START button on the Supervisor's Console; this button is monitored by the SABR function IFLAG.

The Fortran subroutine TIMER is called frequently to check whether the intruder detection button has been pushed by the pilot.

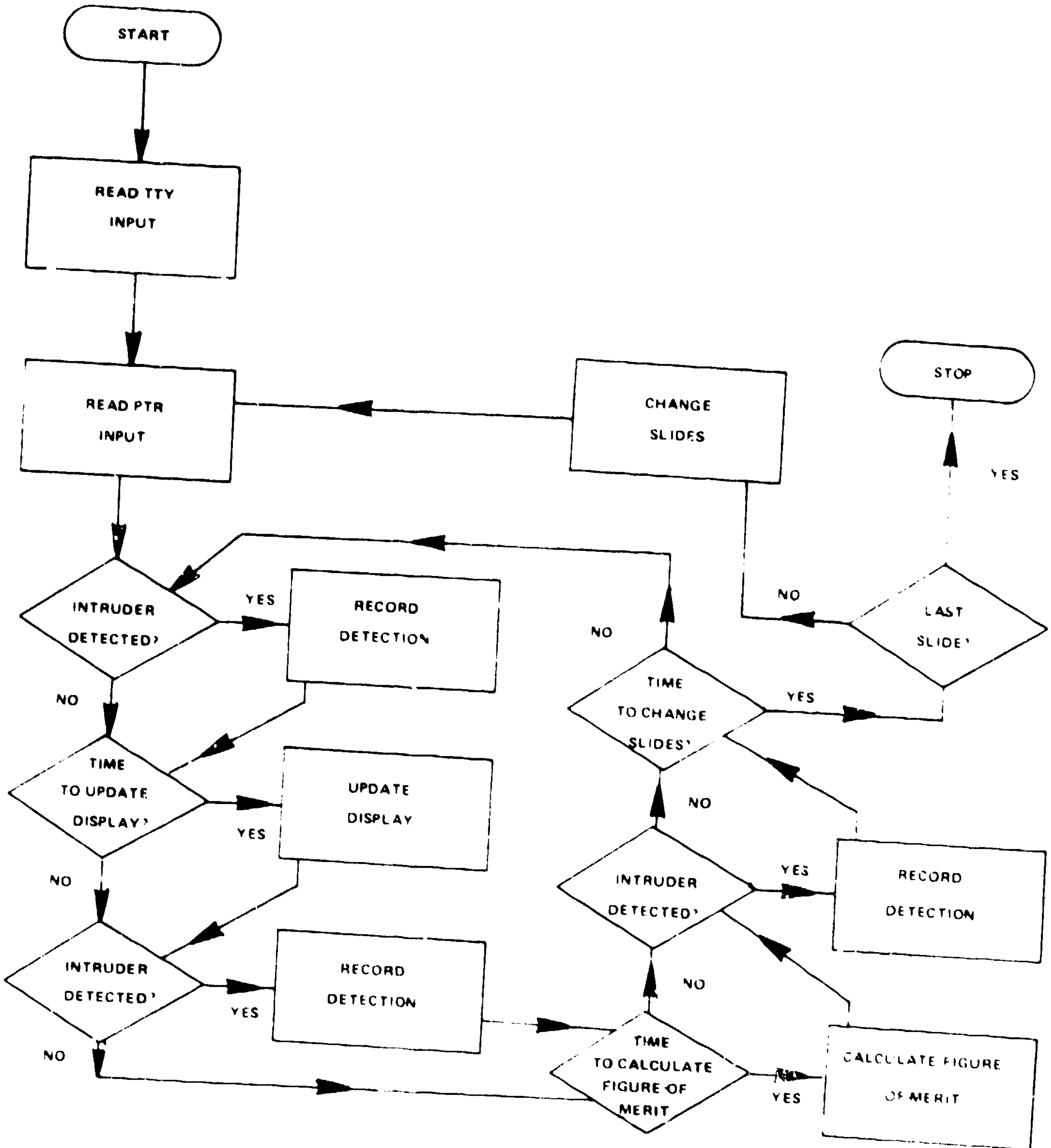


Figure 4-1 Main Program Flowchart

The input intruder angles are corrected for yaw, which is obtained from the SABR function IADC (O). To display this information one or two Fortran subroutines are called: AURAL for an audible alarm, SCTR for a 30^{o} sector display, HDUP for a heads-up display with a 2^{o} accuracy. The possible combinations during an experiment are: if TTY input NDSPL=1, AURAL alone; NDSPL=2, AURAL and SCTR; NDSPL=3, AURAL and HDUP. For demonstration purposes all 3 displays can be turned on simultaneously by setting NDSPL=4.

The Fortran subroutine MERIT is called to calculate the figure-of-merit. The Fortran subroutine SLIDE is called to turn on and off signals to advance slides and to skip slides.

The main program goes through the loop shown in Figure 4-1 many times during the interval a slide is projected. The various subroutines are called at time intervals which are determined from the TTY input, described in more detail in Part V. The present time is obtained by calling TIMER or the SABR function TIME (O). At the end of the trial MERIT is called with the next to the last argument set equal to 500; this produces TTY output from MERIT as described in more detail in Part VI.

The main program occupies 18 pages in the PDP 8/e memory; in addition 4 pages are occupied by common storage.

III. FORTRAN SUBPROGRAMS

The Fortran subprograms were written by Vic Mangulis of Questek, Inc.

A. Subroutine MERIT

Since subroutine MERIT is just as long as the main program, it is divided into six parts, and the first five parts are executed at different times to avoid time delays in the servicing of other peripherials; the sixth part provides TTY output at the end of a trial.

MERIT calculates, for five flight performance quantities, the peak value, the sum-of-squares, and the number of terms in the sum for the difference between a reference quantity set on the Supervisor's Console and the actual value obtained from GAT-1 which is called a "figure-of-merit." The five flight performance quantities are: 1) altitude rate or 2) altitude, 3) speed, 4) heading, or 5) VOR deviation. Either 1) or 2) is calculated at any time, not both. Altitude rate is for calculation during climb or descent; altitude is for calculation during level flight. A switch on the Supervisor's Console specifies which altitude performance measure should be calculated. Similarly either 4) or 5) is calculated, not both, and the choice is indicated by a switch on the Supervisor's Console.

Furthermore, the figure-of-merit is classified according to the alarm state, and a separate tally is kept for each state. The following states are used:

1) No PWI alarm, no targets detected.
2) No PWI alarm, but there are targets which the pilot has detected.
3) A PWI alarm has been given, but all of the targets have not been detected yet.
4) A PWI alarm has been given, and all targets have been detected.

In addition to the alarm state the figure of merit is also calculated separately for a level flight and for a climb/descent; thus there are eight separate tallies of the figure-of-merit (2 altitude states x 4 alarm states. See Part VI).

MERIT calls Fortran subroutine REF to obtain the flight performance reference quantities from the Supervisor's Console. The calculation of the figure of merit for all five quantities is suspended for a time interval TDLY whenever any reference quantity is changed, and the particular quantity which is changed is suspended for an additional time interval XDL which is calculated as (the difference in reference quantities)/(rate of change IRTE for that quantity - and input). A change in VOR is indicated by changing the heading reference switch.

GAT 1 heading is obtained from the A/D converter by calling the SABR functions IADC (2) and IADC (3) for the sine and cosine of the heading angle and then calling the Fortran function XANGLE to obtain the angle as the arctangent of sine/cosine. Other quantities are obtained from IADC with other arguments; see IADC in Part IV, Section IV.

Altitude rate is assumed to be either 0 (level flight), +500 ft./sec., or -500 ft/sec.; whether the flight is supposed to be level or a climb/descent is input from the Supervisor's Console and decoded by REF. In case of climb/descent MERIT decides whether it is supposed to be a climb at 500 ft./sec. or a descent at -500 ft./sec. by a comparison of present altitude and the reference altitude.

MERIT occupies 18 pages of memory.

B. Subroutine REF

REF calls SABR functions IREAD (0) and IREAD (1) to obtain the bits set equal to 1 on digital I/O devices DR8-EA with codes 55 and 56, respectively. The contents of the devices are set by switches on the Supervisor's Console, and are decoded by REF so as to yield reference quantities for MERIT.

REF occupies 11 pages of memory.

C. Subroutine TIMER

TIMER transmits the present value of time through common storage to other parts of the program. Time is obtained by calling the SABR function TIME (0).

When the pilot presses the detection button in GAT-1, the time at which it is pressed is recorded by the digital I/O device DR8-EA with code 50; TIMER calls SABR function TCH 13 (0) to find the value of this time. If a detection has not occurred since the last time TCH 13 was called, TCH 13 returns the value zero.

When a detection has occurred, the angular positions of all visible targets are recorded. Next TIMER expects a screen panel number from the switches on the Supervisor's Console, which is read by SABR function ICH 13 (0). The panel number (1 through 14) is matched up with the nearest visible target within $\pm 20^{\circ}$ of the center-line of the panel; and the target number, the panel number, and the detection time are recorded for output at the end of the run. If there is no visible intruder within $\pm 20^{\circ}$, a target number of -1 is assigned to this detection. If the panel number is 15 (an error indication from the Supervisor's Console), a target number of -1 and a panel number of -2 are assigned. If the panel button is not yet pressed TSUP seconds after the detection, a target number of -1 and a panel number of -1 are assigned.

If the pilot presses the detection button again within 1 second of the previous detection, it is ignored (to avoid multiple detections due to switch bounce). If the target is out of the normal field of view ($\pm 88^{\circ}$) due to yaw, a 100 is added to the panel number upon detection.

While the computer waits for the panel number, other functions are performed normally; i.e., TIMER is called several times each second, each time TIMER checks whether panel number has been recorded (if the value of ICH 13 (0) other than zero), and if not, control is returned to main program.

TIMER occupies 7 pages of memory.

D. Subroutine SCTR

SCTR activates the sector display. If one target is located in one of the six sectors (with boundaries at 0°, $\pm 30^{\circ}$, $\pm 60^{\circ}$, and $\pm 90^{\circ}$, where 0° is the center of the screen), the light in that sector is turned on for the duration of the alarm. If more than one target is located in a sector, the light flashes. The light is turned on by calling the SABR subroutine DRSET; it is turned off by calling DRCLR.

SCTR occupies 4 pages of the memory.

E. Subroutine HDUP

HDUP activates the heads-up display which consists of lights 2° apart around the GAT-1 cockpit window. If a target is located within one of the 2° sectors, that light is flashed. There are 88 lights, numbered from 6 to 93 from left to right so that the lights on both sides of the screen's center are numbered 49 and 50.

To turn on a light, SABR subroutine HUD is called with two arguments: the first argument indicates the units digit, the second argument the tens digit of the light number. To turn off all lights, HUD is called with both arguments equal to zero. Four lights can be flashed during a normal display cycle; if more than four targets are present, then the display will be cycled through all targets; for example, for 6 targets it will display 1, 2, 3, 4 the first time; 3, 4, 5, 6 the next time; then 5, 6, 1, 2, etc.

HDUP occupies 3 pages of memory.

F. Subroutine AURAL

AURAL activates the audible alarm; a beep is heard for each target, up to a maximum of 5 beeps. The sequence of beeps is repeated at intervals of TAUR seconds (an input). To turn the alarm on and off, AURAL calls SABR subroutines DRSET and DRCLR.

AURAL occupies 2 pages of memory.

G. Subroutine SLIDE

SLIDE changes slides (only on left or right, or on both sides of screen) and skips slides in the tray which is not being projected. SLIDE calls SABR subroutines DRSET and DRCLR to turn changing and skipping signals on and off.

SLIDE occupies 3 pages of memory.

H. Functions XANGLE and XX

XX provides a simple but sufficiently accurate arctangent of its argument for angles between $\pm 45^{\circ}$; XANGLE provides an arctangent for angles between $\pm 180^{\circ}$; it first examines the sine and cosine (arguments of XANGLE) for sign and magnitude, and then calls XX.

XANGLE occupies 4 pages and XX 1 page of memory.

I. Subroutine DECOD

DECOD converts digits stored in an array IRAY into integers from 0 to 2047. PTR deposits digits from the paper tape into IRAY while the rest of the program is being executed. Those digits are then decoded by DECOD according to the format specified.

DECOD occupies 3 pages of memory.

J. Digital Equipment Corporation's 8K Paper Tape Fortran Library Subroutines

The following standard DEC Fortran library subroutines are used:

1) IOH, 11 pages of memory, handles TTY input and output
2) FLOAT, 6 pages, does floating point arithmetic
3) INTEGER, 2 pages, handles integer arithmetic
4) UTILITY, 1 page, initializes TTY
5) ERROR, 2 pages, prints encountered errors
6) SUBSC, 1 page, calculates addresses of subscripted array variables

The subroutines are described in "Programming Languages," PDP-8 Handbook Series published by DEC, pp. 15-55 to 15-63.

IV. SABR SUBPROGRAMS

The SABR subprograms for VDS were written by Charles Romeo of the DEC office in Waltham, Massachusetts. They occupy 4 pages of memory, and they handle input and output on the peripherals.

A. Function TIME (D)

TIME returns current time in units of .01 second from the DK8-E real-time clock. Time is set equal to zero at the instant when the START button is pressed on the Supervisor's Console. D is a dummy argument; any value can be used.

B. Function IADC (N)

IADC returns contents of A/D converter channel N, $0 \leq N \leq 8$. The A/D converter is connected to outputs from GAT-1 and the Supervisor's Console. N=0 returns the sine of yaw angle. N=1 is not used. N=2 and 3 give the sine and cosine of the heading angle respectively. N=4 returns airspeed, N=5 true altitude, N=6 rate of climb, N=7 VOR deviation, N=8 barometric pressure.

C. Function IFLAG (D)

IFLAG monitors the START, STOP, and CONTINUE buttons on the Supervisor's Console. D is a dummy argument.

D. Function ICH 13(D)

ICH 13 monitors the screen-panel-number buttons on the Supervisor's Console. D is a dummy argument. When a screen-panel-number button is pressed, ICH 13 is set equal to the panel number; it is returned to value zero when it has been read by TIMER.

E. Function TCH 13 (D)

When the pilot presses the detection button, TCH 13 is set equal to the time at which this occurred. TCH 13 is zeroed when it has been read by TIMER. D is a dummy argument.

F. Subroutine HUD (I,J)

HUD is called by HDUP to activate the heads-up display. $I=2^{11-U}$ and $J=2^{11-T}$ where U and T are the units and tens digits of the heads-up display light number. HUD outputs I and J on DR8-EA devices 52 and 54.

G. Subroutines DRSET (I,J) and DRCLR (I,J)

I designates a DR8-EA device code, I=0 corresponds to device 55; I=1 device 56. If B is the bit position on the DR8-EA, $0 \le B \le 11$, then $B=2^{11-J}$. DRSET sets bit B equal to 1 on device designated by I. DRCLR sets bit B equal to 0. Programs which call DRSET and DRCLR must be located in the same field of memory.

H. Function IREAD (I)

I has same meaning as for DRSET and DRCLR. IREAD returns the contents of the device designated by I.

I. Subroutine INIT

INIT sets up gains for A/D channels, disables unnecessary interrupts (TTY, etc.), enables interrupts on DR8-EA devices 50 and 51.

J. Subroutine RPPT (IRAY)

RPPT enables the computer to read paper tape input through the PTR on an interrupt basis while the rest of the program is being executed. A call to RPPT deposits one record from paper tape in memory in an array IRAY, starting at location 2. A record is terminated by a colon, line feeds are ignored, only zeros or positive integers are allowed. IRAY (1) is used to monitor reading; it is 0 if reading is still in process, greater than 0 if finished without errors, less than 0 if errors encountered.

V. INPUT FROM TTY AND PTR

A. TTY

The input format is specified in the program listing, see Part IX.

NUMB: pilot identification number.
NDSPL: display number, see Part II.
IRTE(N), N=3,4,1: rate of change of a flight performance quantity, see Part III.A.
TUPDT: time interval at which display is updated, also, duration of sector display light flash if more than one target in sector.
TDLY: time interval during which figure of merit calculations are suspended, see Part III.A.
TAUR: time interval at which sequences of beeps are repeated.
TBEEP: duration of a beep.
TREPT: duration of signal transmitted to projectors to advance or skip
TSUP: maximum time which the computer waits for a screen panel number after detection, see Part III.C.
TSLID: time interval at which slides are changed.
TMERT: time interval at which figure of merit is calculated.
TIMO: time at which display updating and sector display cycle is begun.
TIM1: time at which figure of merit calculations are begun.
TIM2: time at which slide advance is begun.
TIM4: time at which first audible beep is begun.
TIM5: time at which beep sequence is begun.
TIM6: time at which heads up display cycle is begun.

B. PTR

Only positive integers or zero are input through PTR. End of a record is indicated by a colon. Line feeds are ignored.

A heading for each paper tape consists of scenario number (5 digits), number of slides in scenario (4 digits), a PWI number (4 digits).

The scenario number is coded as follows:

1st digit identifies slide scenario, 1-4
2nd digit = 0 for no PWI
= 1 for PWI with alarm range of 9000'
= 2 for PWI with alarm range of 15,000'
3rd digit = 0 if no false alarms
= 1 for 1 false alarm
= 2 for 2 false alarms
= 3 for 5 false alarms
4th digit = 0 if no missed alarms
= 1 if 10% of alarms are missed
= 2 if 50% of alarms are missed
5th digit = 0 if no skipped slides, high traffic density
= 1 if slides are skipped, low traffic density

Next, for each slide the following integers are input:

L2 (3 digits): slide sequence number
MDVS2 (2 digits): number of PWI alarms for visible targets
NDTV2 (2 digits): number of visible targets which have not generated PWI alarms
MDIN2 (2 digits): number of PWI alarms for invisible targets
NSKE 1 (1 digit). number of slides to be skipped in even tray; also, if 5 or greater, stops or restarts slide advance on the right side of screen
NSKO 1 (1 digit): number of slides to be skipped in odd tray; also, if 5 or greater, stops or restarts slide advance on the left side of screen.

If either MDVS2 or MDIN 2 is not zero, the paper tape will contain also the following (MDIN2 first then MDVS2) for each target:

INTR2 (2 digits): target identification number
JF2 (2 digits): angular position of intruder expressed as the heads-up display light number
IDTB2 (2 digits): pulse at which PWI alarm should be turned on (PWI pulses are assumed to arrive at 0.5 second intervals)
IDTE2 (2 digits): pulse at which PWI alarm should be turned off

If NDTV2 is not zero, the above will be followed by INTR2 and JF2 for NDTV2 targets.

The very last entry on the tape should be the above input for a slide sequence number which exceeds by 1 the actual number of slides; this will trigger the hardcopy output for the experimental run.

VI. OUTPUT ON TTY

At the beginning of the trial the TTY echoes the input and types out a heading with a scenario number, PWI number, display number, and pilot number.

At the end of the run, 2 groups of numbers are output: a) figure-of-merit data, b) detection data.

The figure-of-merit data consist of 40 rows and 5 columns. The first column contains an integer from 1 to 8, which indicates the alarm state and altitude rate state for the calculation:

1: PWI alarm is on, all targets have not been detected yet, pilot is still searching; level flight
2: PWI alarm is on, all targets detected level flight
3: no alarms, no detected targets, level flight
4: no alarms, but targets have been detected, level flight
5: same as 1, but climb/descend
6: same as 2, but climb/descend
7: same as 3, but climb/descend
8: same as 4, but climb/descend

The second column contains an integer from 1 to 5 and indicates the type of flight performance quantity:

1: altitude rate
2: altitude
3: airspeed
4: heading
5: VOR deviation

The third column shows the number of terms in the sum of squares. The fourth column shows the sum of squares of deviations, the fifth column shows peak deviation. The units are: 1) for altitude rate one unit is 24.4 ft./min., 2) for altitude one unit is 13 ft., 3) for airspeed one unit is 0.945 knot; 4) for heading one unit is 1°, 5) for VOR deviation one unit is a deviation of 0.0976°

For some combinations of columns 1 and 2 there will be no entries in columns 3, 4, and 5 because the combination cannot occur; e.g., during level flight 4-8 in column 1 and 2 in column 2 will have zero entries because altitude deviation is not calculated during climb/descent. Space was still allowed for such impossible entries because it required less computer memory to accommodate such entries than to check and bypass them.

The detection data consist of 3 columns.

The first column shows the target number. A -1 will appear if: a) there was no target within 20° of the centerline of the indicated screen panel, b) the screen panel button was not yet pressed TSUP seconds after the detection button had been pressed, c) the error button was pressed instead of the screen panel button.

The second column shows the screen panel number for the detected target, usually an integer from 1 to 14. A 100 will be added to this number if the target was out of the normal field of view (+88°) because of yaw. A -1 will appear if the screen panel button was not pressed TSUP seconds after detection. A -2 will appear if the error button was pressed.

The third column shows the time in seconds at which the detection button was pressed.

VII. ERROR MESSAGES

The following error messages are typed on TTY by the Fortran program:

> READ ERROR XXX: at slide sequence number XXX, either the SABR subroutine RPPT found an error in the paper tape read by PTR, or the slide sequence number on the tape does not match the tally kept by the computer.
>
> DIGIT ERROR XXXX YYYY: the number XXXX element of the PTR input array IRAY cannot be decoded by Fortran subroutine DECODE as an Integer between 0 and 9; instead it has the value YYYY.

The following error messages are typed on TTY by DEC's 8K paper tape Fortran Library subroutine ERROR, and they are discussed in more detail in "Programming Languages," published by DEC, pp. 15-87 to 15-88:

DIVZ: attempt to divide by zero
FMT1: multiple decimal points
FMT2: E or "." in integer
FMT3: illegal character in I, E, or F field
FMT4: multiple minus signs
FMT5: invalid format statement
FPNT: floating point error; may be caused by division by zero, or floating point overflow, or attempt to fix too large a number

VIII. PROGRAM LOADING

The program is loaded into the computer by the use of DEC's 8K System Linking Loader. The procedure is described in "Programming Languages," published by DEC, pp. 13-55 to 13-57. Table 4-I presents the program name, field setting, and sequence in which to load the program.

The following restrictions should be observed: a) a program that uses common storage, either the main program (also called VDS), or MERIT, TIMER, or DECOD, must be loaded first; b) the SABR subprograms that are all punched on a paper tape marked QUEST. 15, must be loaded into field 0; c) all programs that call DRCLR and DRSET (SLIDE, AURAL and SCTR) must be located in the same field.

IX. DATA TRANSFER TO HP2100 MINICOMPUTER

The VDS data are to be analyzed off-line on a Hewlett Packard 2100 mini-computer. A Fortran IV package has been developed which transfers the VDS paper tape output to disk and magnetic tape files on the HP system. The package is comprised of four programs, VDATA, SET, READV, and READD.

A. VDATA

VDATA is the main program in the Fortran package. The program has two primary functions. First, it reads the VDS input data and simultaneously creates a disk file and a mag tape file for each individual. The disk file is named VXXXX where XXXX is the subject's four-digit identification number. The first record of each mag tape file contains the name VXXXX for identification.

The second function of the program is to update the index file, VINDX. With each program run, VINDX is used to determine the next available mag tape file which can be used for the data storage. This file is continually updated so that the VDS files can be sequentially stored on one tape. VINDX is located on the disk, and each updated version is written on the last file of the magnetic tape.

The paper tape output from an individual's VDS run comprises the data for each file. A -9 ASCII value must be added to the final paper tape output. This value is recognized by VDATA as an end-of-file mark for a subject's data.

B. SET

SET initializes the disk file, VINDX. VINDX is the index file for the magnetic tape and contains the file number for each subject VXXXX. This file is addressed by VDATA in order to determine the next available file which can be used to update the file when data have been stored on the magnetic tape.

C. READV

READV is a fortran program which reads the index file and displays the contents on the CRT.

D. READD

READD reads the contents of a disk file. To check a magnetic file transfer the contents of the file to a disk file and use READD.

E. PROCEDURES

1. Load VDS Disk Pack.
2. Run SET. This should only be used once when storing the first file otherwise the index file will be destroyed.
3. Load the VDS magnetic tape.
4. Put the paper tape input into the tape reader.
5. Run VDATA.
6. If a -9 ASCII value has not been added to the tape, place a tape that contains this value in the reader after the data input has been read.
7. Run READD to check the new files.

Table 4-1

Program Name	Date Last Revised	Field Setting
VDS. Assembled (Main Program)	1/22/74	1
QUEST. 15	6/14/73	0
SLIDE. Assembled	5/18/73	0
AURAL. Assembled	4/13/73	0
SCTR. Assembled	6/14/73	0
TIMER. Assembled	1/22/74	0
HDUP. Assembled	6/04/73	0
XANGL. Assembled	6/14/73	0
XX. Assembled	6/14/73	1
DECOD. Assembled	1/22/74	1
MERIT. Assembled	1/22/74	2
REF. Assembled	1/31/74	2
DEC FORTRAN LIBRARY*. PART 1, Program 1		3
PART 1, Program 2		3
PART 1, Program 3		1
PART 1, Program 4		2
PART 1, Program 5		1
PART 2, Program 1		3

* Several of the programs are punched together on the same tape. The computer will stop after each program.

X. PROGRAM LISTINGS

A. VDS FORTRAN PROGRAMS

```
C         P R O G R A M    V D S
      COMMON KDET,LDET,MTOT2,INTR2,JF2,TIM,MDIN2,TT,NUMB
     1,JDR,JP,IRAY,TSUP
      DIMENSION IDTB2(10),IDTE2(10),LDET(70),INTR2(10)
     1,JF(10),NSK(4),MDSP(6),TT(70),JDR(70),JP(12),
     2 JF2(10),IRTE(4),IRAY(100)
      CALL INIT
      CALL RPPT(IRAY)
      READ (1,50) NUMB,NDSPL,IRTE(3),IRTE(4),IRTE(1),TUPDT
     1,TDLY,TAUR,TBEEP,TREPT,TPROJ,TSUP
50    FORMAT (I4/4I4,3F12.6/4F12.6)
      READ (1,55) TSLID,TMERT,TIM0,TIM1,TIM2,TIM4,TIM5,TIM6
55    FORMAT (5F10.5/3F10.5)
      WRITE (1,60) NUMB,NDSPL,IRTE(3),IRTE(4),IRTE(1),TUPDT
     1,TDLY,TAUR,TBEEP,TREPT,TPROJ,TSUP
60    FORMAT ('  ',I4/4I4,3F12.6/4F12.6/)
      WRITE (1,55) TSLID,TMERT,TIM0,TIM1,TIM2,TIM4,TIM5,TIM6
      CALL DECOD(2,3,KDSP)
      CALL DECOD(5,2,NPLS)
      CALL DECOD(7,4,NSL)
      CALL DECOD(11,4,JDSP)
      WRITE (1,220) KDSP,NPLS,JDSP,NDSPL,NUMB
220   FORMAT (/' SCENE: ',I3,I2,' PWI: ',I4,' DISPLAY: ',
     1 I4,' PILOT: ',I5//)
      NPLS=2
      LI=0
      KDET=0
      NUMB=0
      KDSP=0
      JDSP=0
      KUPDT=0
      TEND=2.5*TBEEP
      JALD=1
      TMRIT=0.2*TMERT
      NOFFL=0
      NOFFR=0
      MDET2=0
      IRTE(2)=70
      JP(1)=1
      DO 225 J=2,12
      JP(J)=2*JP(J-1)
225   CONTINUE
      DO 230 J=1,6
      MDSP(J)=0
230   CONTINUE
240   LI=LI+1
      CALL RPPT(IRAY)
```

```
300    IF (LI-1) 650,650,435
435    CALL TIMER
       IF (TIM-TIM0) 515,450,450
450    TIM0=TIM0+TUPDT
       ITM=NPLS*IFIX(TIM-TIM2)
       LD=0
       IF (MTOT2) 502,502,460
460    KORR=(5*IADC(0))/34
       DO 500 K=1,MTOT2
       IF (K-MDET2) 465,465,500
465    IF (ITM-IDTB2(K)) 500,480,480
480    IF (ITM-IDTE2(K)) 485,500,500
485    LD=LD+1
       JF(LD)=JF2(K)+KORR
       IF (JF(LD)-6) 490,500,495
490    JF(LD)=6
       GO TO 500
495    IF (JF(LD)-93) 500,500,497
497    JF(LD)=93
500    CONTINUE
502    IF (NDSPL-4) 505,510,505
505    IF (NDSPL-2) 515,510,515
510    CALL SCTR(JF,MDSP,LD,JP)
515    TIM=.01*TIME(0)
       IF (TIM-TIM4) 535,520,520
520    TIM4=TIM4+TBEEP
       IF (LD) 525,525,530
525    IF (KDSP) 535,535,530
530    KUPDT=KUPDT+1
       IF (TIM-TIM5+TEND) 533,533,532
532    KUPDT=12
533    CALL AURAL(LD,KUPDT,KDSP,JP(12))
535    IF (TIM-TIM5) 545,540,540
540    TIM5=TIM5+TAUR
       KUPDT=0
545    IF (NDSPL-2) 581,581,550
550    IF (TIM-TIM6) 581,555,555
555    TIM6=TIM6+TREPT
       JDSP=JDSP+1
       CALL HDUP(JF,LD,JDSP,JP)
581    CALL TIMER
       IF (TIM-TIM1) 610,600,600
600    CALL MERIT(IRTE,TDLY,TMERT,JALD,LD,TIM2,LD,TIM1)
       TIM1=TIM1+TMRIT
610    TIM=.01*TIME(0)
       IF (TIM-TIM3) 640,620,620
```

```
620   CALL SLIDE(NSK,ISET,JP)
      TIM3=TIM3+TPROJ
640   IF (TIM-TIM2-TSLID) 435,645,645
645   TIM2=TIM2+TSLID
650   IF (L1-1) 655,655,660
655   J=IFLAG(0)
      IF (J) 655,655,660
660   TIM=.01*TIME(0)
      IF (NOFFR) 665,665,670
665   NSK(2)=1
670   IF (NOFFL) 675,675,680
675   NSK(1)=1
680   ISET=0
      CALL SLIDE(NSK,ISET,JP)
700   IF (IRAY(1)) 710,730,740
710   WRITE (1,720) L1
720   FORMAT (' READ ERROR', I3)
      STOP
730   GO TO 700
740   CALL DECOD(2,3,L2)
      IF (L2-L1) 710,750,710
750   CALL DECOD(5,2,MDVS2)
      CALL DECOD(7,2,NDTV2)
      CALL DECOD(9,2,MDIN2)
      CALL DECOD(11,1,NSKE1)
      CALL DECOD(12,1,NSKO1)
      NSTRT=13
      MDET2=MDVS2+MDIN2
      MTOT2=MDET2+NDTV2
      IF (MTOT2) 800,800,760
760   DO 780 J=1,MTOT2
      CALL DECOD(NSTRT,2,INTR2(J))
      CALL DECOD(NSTRT+2,2,JF2(J))
      NSTRT=NSTRT+4
      IF (J-MDET2) 770,770,780
770   CALL DECOD(NSTRT,2,IDTB2(J))
      CALL DECOD(NSTRT+2,2,IDTE2(J))
      NSTRT=NSTRT+4
780   CONTINUE
800   IF (NSKE1-5) 910,900,900
900   NOFFR=1-NOFFR
      NSKE1=NSKE1-5
910   NSK(4)=NSKE1
      IF (NSKO1-5) 930,920, 920
```

```
920    NOFFL=1-NOFFL
       NSKO1=NSKO1-5
930    NSK(3)=NSKO1
       TIM3=TIM+TPROJ
       IF (L2-NSL) 240,240,960
960    CALL TIMER
       IF (TIM-TIM3) 960,980,980
980    CALL SLIDE(NSK,ISET,JP)
       CALL SCTR(JF,MDSP,3,JP)
       CALL HDUP(JF,0,1,JP)
       CALL MERIT(IRTE,TDLY,TMERT,JALD,LD,TIM2,500,TIM1)
       STOP
       END


C
       SUBROUTINE MERIT(IRTE,TDLY,TMERT,JALD,LD,TIM2,L2,TIM1)
       COMMON KDET,LDET,MTOT2,INTR2,JF2,TIM,MDIN2,TT,NUMP,
      1 JDR,JP,IRAY,TSUP
       DIMENSION SUM(5,8),IPK(5,8),IN(5,8),IRF3(5),
      1 MDL(5),IRTE(4),LDET(70),INTR2(10),JF2(10),
      2 TT(70),KRF(5),IRF2(5),IVL(5),JDR(70),
      3 IRAY(100),JP(12)
       IF (L2-500) 5,660,660
5      GO TO (7,50,310,320,500),JALD
7      IF (L2-1) 10,10,30
10     DO 20 J=1,6
       DO 20 L=1,5
       SUM(L,J)=0.
       IPK(L,J)=0
       IN(L,J)=0
20     CONTINUE
       MDLY=0
30     CALL REF(JP,KRF,IRF2,ISUSP)
       JALD=2
       RETURN
50     IF (KRF(2)) 140,140,130
130    M1=2
       IRRF2(1)=0
       GO TO 190
140    M1=4
       IF (IVL(2)-IRF2(2)) 150,160,180
```

```
160     IRF2(1)=20
        GO TO 190
180     IRF2(1)=-20
190     IRF2(5)=0
        KRF(3)=1
        IF (L2-1) 300,300,200
200     DO 290 L=1,4
        J=IABS(IRF2(L))+IABS(IRF3(L))
        IF (J) 290,290,210
210     J=IABS(IRF2(L)-IRF3(L))
        IF (J) 290,290,220
220     IF (MDLY) 230,230,240
230     TIM1=TIM1+TDLY
        MDLY=1
        JALD=1
        RETURN
240     XDL(L)=FLOAT(J/IRTE(L))
290     CONTINUE
300     S=IADC(2)
        S=-S*9.766E-04
        C=IADC(3)
        C=-C*9.766E-04
        JALD=3
        RETURN
310     IVL(4)=XANGLE(S,C)
        JALD=4
        RETURN
320     IVL(5)=IADC(7)/10
        IVL(3)=15-IADC(4)/8
        IVL(1)=-IADC(6)/10
        J=IADC(8)/14
        IVL(2)=-IADC(5)+J+8
        XDL(5)=XDL(4)
400     IDT=0
        IF (KDET) 505,505,420
420     JJ=MDIN2+1
        DO 500 J=1,KDET
        IF (TT(J)-TIM2) 460,490,490
460     IF (MTOT2-MDIN2) 500,500,470
470     DO 480 L=JJ,MTOT2
        IF (INTR2(JJ)-LDET(J)) 480,490,480
480     CONTINUE
         GO TO 500
490      IDT=IDT+1
```

```
500   CONTINUE
505   JALD=5
      RETURN
507   IF (LD) 510,510,540
510   IF (IDT) 520,520,530
520   MI=MI+3
      GO TO 570
530   MI=MI+4
      GO TO 570
540   IF (LD-IDT) 550,550,560
550   MI=MI+2
      GO TO 570
560   MI=MI+1
570   DO 650 L=1,5
      IRF3(L)=IRF2(L)
      IF (L2-1) 650,650,572
572   IF (ISUSP) 575,575,650
575   IF (XDL(L)) 590,590,580
580   XDL(L)=XDL(L)-TMERT
      GO TO 650
590   IF (KRF(L)) 650,650,600
600   J=IABS(IVL(L)-IRF2(L))
      IN(L,MI)=IN(L,MI)+1
      IF (L-4) 630,610,630
610   IF (J-180) 630,630,620
620   J=360-J
630   IF (J-45) 635,635,632
632   S=FLOAT(J)
      SUM(L,MI)=SUM(L,MI)+S*S
      GO TO 638
635   SUM(L,MI)=SUM(L,MI)+FLOAT(J*J)
638   IF (J-IPK(L,MI)) 650,650,640
640   IPK(L,MI)=J
650   CONTINUE
      MDLY=0
      JALD=1
      RETURN
660   DO 680 MI=1,8
      DO 680 L=1,5
       WRITE (1,670) MI,L,IN(L,MI),SUM(L,MI),IPK(L,MI)
670   FORMAT ('  ',2I2,I4,E13.5,I4)
680   CONTINUE
      DO 700 L=1,KDET
      WRITE (1,690) LDET(L),JDR(L),TT(L)
690   FORMAT ('    ',2I4,F10.3)
700   CONTINUE
720   RETURN
      END
```

```
C
      SUBROUTINE REF(JP,KRF,IRF2,ISUSP)
      DIMENSION LRF(4),KRF(5),IRF2(5),JP(12)
      ISUSP=0
      J=IREAD(0)
      LRF(1)=-1
      LRF(2)=5
      DO 62 L=1,2
      DO 60 K=1,6
      II=12-K-LRF(L)
      MI=J-JP(II)
      IF (MI) 60,40,40
40    J=MI
      IF (L-1) 45,45,55
45    IF (K-2) 52,50,55
50    ISUSP=1
      GO TO 60
52    KRF(1)=1
      GO TO 60
55    KRF(L)=K
      GO TO 62
60    CONTINUE
62      CONTINUE
      IF (KRF(2)-2) 65,68,72
65    IRF2(2)=0
      GO TO 75
68    IRF2(2)=77*(2-J)
      GO TO 75
72    IRF2(2)=77*KRF(2)-38*J
75    IF (KRF(1)-2) 80,83,86
80    IRF2(3)=87
      GO TO 100
83    IRF2(3)=90
      GO TO 100
86    IRF2(3)=96+5*(KRF(1)-3)
100   J=IREAD(1)
      KRF(1)=0
      KRF(2)=4
      KRF(3)=8
       KRF(4)=10
      LRF(1)=1
      LRF(2)=10
      LRF(3)=100
      II=0
      IF (J-JP(12)) 105,110,110
105   KRF(5)=1
```

```
      GO TO 115
110   KRF(5)=0
      J=J-JP(12)
115   DO 160 L=1,3
      JJ=0
      KK=KRF(L+1)-KRF(L)
      DO 140 K=1,KK
      MI=12-K-KRF(L)
      MI=J-JP(MI)
      IF (MI) 140,120,120
120   J=MI
      JJ=JJ+JP(K)
140   CONTINUE
      II=II+JJ*LRF(L)
160   CONTINUE
      IF (II-180) 190,190,170
170   II=II-360
190   IRF2(4)=II
      KRF(4)=1-KRF(5)
      IF (J) 220,220,200
200   KRF(1)=1
      GO TO 240
220   KRF(1)=0
240   KRF(2)=1-KRF(1)
      RETURN
      END


C
      SUBROUTINE TIMER
      COMMON KDET,LDET,NTOTR,INTR2,JF2,TIM,MDIN2,TT,NUMB,
     1 JDR,JP,IRAY,TSUP
      DIMENSION LDET(70),INTR2(10),TT(70),JF2(10),JDR(70)
     1 ,JP(12),IRAY(100),JF(10),INTR(10),IS(10)
      TIM=.01*TIME(0)
      P=.01*TCH13(0)
      IF (KDET) 2,2,4
2     C=P
      GO TO 5
4     C=P-TT(KDET)-1.
5     IF (C) 14,14,6
6     KDET=KDET+1
      TT(KDET)=P
```

```
      NUMB=NUMB+1
      MTOT=MTOT2
      MDIN=MDIN2
      IF (MTOT) 14,14,8
8     KORR=(5*IADC(0))/34
      DO 13 II=1,MTOT
      INTR(II)=INTR2(II)
      JF(II)=JF2(II)
      IF (JF(II)+KORR-6) 9,10,10
9      IS(II)=100
      GO TO 13
10    IF (JF(II)+KORR-93) 12,12,9
12    IS(II)=0
13    CONTINUE
14    J=ICH13(0)
      M=KDET-NUMB
      IF (NUMB) 530,530,15
15    IF (J) 32,32,17
17    IF (J-15) 40,20,530
20    JDR(M+1)=-2
      GO TO 510
32    IF (TIM-TT(M+1)-TSUP) 530,530,35
35    JDR(M+1)=-1
      GO TO 510
40    LC=400
      LP=(7-J)*63
      LP=LP/10
      LP=47-LP
100   JDR(M+1)=J
      IF (MTOT-MDIN) 510,510,220
220   J=MDIN+1
      DO 500 II=J,MTOT
      I=INTR(II)
      IF (M) 300,300,270
270   DO 280 MM=1,M
      IF (I-LDET(MM)) 280,500,280
280   CONTINUE
300   LLD=IABS(LP-JF(II))
      IF (LLD-LC) 350,500,500
350   LC=LLD
      INT=I
       IOFF=IS(II)
500   CONTINUE
      IF (LC-10) 520,510,510
510   INT=-1
520   LDET(M+1)=INT
      JDR(M+1)=JDR(M+1)+IOFF
527   NUMB=NUMB-1
530   RETURN
      END
```

```
C
      SUBROUTINE SCTR(JF,MDSP,LD,JP)
      DIMENSION L(10),JF(10),MDSP(6),JP(12)
      IF (LD) 52,52,40
40    DO 50 I=1,LD
      L(I)=(JF(I)+10)/15
50    CONTINUE
52    DO 140 II=1,6
      KOUNT=0
      KK=JP(13-II)
      IF (LD) 75,75,55
55    DO 70 I=1,LD
      IF (II-L(I)) 70,60,70
60    KOUNT=KOUNT+1
70    CONTINUE
75    IF (KOUNT-1) 80,100,95
80    IF (MDSP(II)) 140,140,90
90    CALL DRCLR(0,KK)
      MDSP(II)=0
      GO TO 140
95    IF (MDSP(II)) 110,110,90
100   IF (MDSP(II)) 110,110,140
110   CALL DRSET(0,KK)
      MDSP(II)=1
140   CONTINUE
      RETURN
      END
C


C
      SUBROUTINE HDUP(JF,LD,JDSP,JP)
      DIMENSION JF(10),JP(12)
      IF (LD-JDSP) 20,90,90
20    IF (ICHK) 40,40,30
30    CALL HUD(0,0)
      ICHK=0
40    IF (JDSP-4) 160,150,160
90    DO 120 L=1,10
      LTEN=10-L
      LUNIT=JF(JDSP)-10*LTEN
      IF (LUNIT) 120,100,100
100   IF (LUNIT-9) 110,110,120
110   LTEN=JP(12-LTEN)
      LUNIT=JP(12-LUNIT)
      GO TO 130
120   CONTINUE
      RETURN
```

```
130   CALL HUD(LUNIT,LTEN)
      ICHK=1
      IF (LD-JDSP) 160,140,162
140   IF (JDSP-4) 160,150,152
150   JDSP=0
160   RETURN
      END
C


C
      SUBROUTINE AURAL(LD,KUP,KDSP,J)
      IF (LD-4) 5,5,10
5     MD=LD
      GO TO 15
10    MD=5
15    IF (KDSP) 18,18,30
18    IF (KUP-2*MD) 20,20,35
20    CALL DRSET(1,J)
      KDSP=1
      RETURN
30    CALL DRCLR(1,J)
      KDSP=0
35    RETURN
      END


C
      SUBROUTINE SLIDE(NSK,ISET,JP)
      DIMENSION NSK(4),JP(12)
      IF (ISET) 10,10,60
10    DO 40 K=1,4
      IF (NSK(K)) 40,40,20
20    J=JP(K)
      CALL DRSET(1,J)
      IF (K-1) 40,40,50
40    CONTINUE
50    ISET=1
      RETURN
600    DO 100 K=1,4
      IF (NSK(K)) 100,100,80
80     J=JP(K)
```

```
      CALL DRCLR(I,J)
      NSK(K)=NSK(K)-1
      IF (K-1) 100,100,120
100   CONTINUE
120   ISET=0
      RETURN
      END


C
      FUNCTION XANGLE(UPP,DWN)
      ADWN=ABS(DWN)
      AUPP=ABS(UPP)
      IF (ADWN-AUPP) 10,10,60
10    IF (AUPP-1.E-8) 20,20,30
20    XANGLE=0.
      RETURN
30    Y=DWN/UPP
      IF (UPP) 40,50,50
40    XANGLE=-90.-XX(Y)
      RETURN
50    XANGLE=90.-XX(Y)
      RETURN
60    IF (DWN) 80,65,65
65    IF (AUPP-1.E-8) 20,20,70
70    Y=UPP/DWN
      XANGLE=XX(Y)
      RETURN
80    IF (AUPP-1.E-8) 85,85,90
85    XANGLE=180.
      RETURN
90    Y=UPP/DWN
      IF (UPP) 95,100,100
95    XANGLE=-180.+XX(Y)
      RETURN
100   XANGLE=180.+XX(Y)
      RETURN
      END
C
```

```
C
      FUNCTION XX(A)
10    B=1.+.28*A*A
      XX=57.296*A/B
      RETURN
      END
C

      SUBROUTINE DECOD(NSTRT,MTIM,LRSLT)
      COMMON KDET,LDET,MTOT2,INTR2,JF2,TIM,MDIN2,TT,NUMB,
     1 JDR,JP,IRAY
      DIMENSION LDET(70),INTR2(10),JF2(10),TT(70),JDR(70)
     1,JP(12),IRAY(100),NP(4)
C     ONLY POSITIVE INTEGERS ALLOWED, <2048
      LRSLT=0
      NP(1)=1
      NP(2)=10
      NP(3)=100
      NP(4)=1000
      DO 50 I=1,MTIM
      M=NSTRT+MTIM-I
      N=IRAY(M)-48
      IF (N-10) 10,20,20
10    IF (N) 20,40,40
20    WRITE (1,30) M,N
30    FORMAT (' DIGIT ERROR', 2I4)
      STOP
40    LRSLT=LRSLT+N*NP(I)
50    CONTINUE
      RETURN
      END
```

B. VDS SABR SUBROUTINES

```
/PAGE 1
/****  QUEST.15
/SPECIAL ROUTINES FOR QUESTEK
/TO BE RUN WITH 8K FORTRAN
/
/
/
/
LAP
ABSYM TEMP0 150
ABSYM TEMP1 151
ABSYM TEMP2 152
ABSYM CLK0 153
ABSYM CLK1 154
ABSYM CLK2 155
ABSYM CH13 156
ABSYM SAVE 157
ABSYM TIME0 160
ABSYM TIME1 161
ABSYM TIME2 162
ABSYM STCLR 163
ABSYM RET1 164
ABSYM RET2 165
ABSYM TMPPTR 166
ABSYM ADCVAL 167
ABSYM COUNT 170
ABSYM STARTF 171
ABSYM PTPTR 172
ABSYM PTFLG 173
ABSYM PTSTAT 174
/
/
/   DC1
/
OPDEF DBDI1 6500
OPDEF DBEI1 6501
OPDEF DBSK1 6502
OPDEF DBCI1 6503
OPDEF DBRI1 6504
/
/
/   DC2
/
OPDEF DBDI2 6510
OPDEF DBEI2 6511
OPDEF DBSK2 6512
OPDEF DBCI2 6513
OPDEF DBRI2 6514
/
/
```

```
/     DC3
/
OPDEF DBDI3 6520
OPDEF DBCO3 6525
OPDEF DBSO3 6526
/
/
/    DC4
/
OPDEF DBDI4 6540
OPDEF DBCO4 6545
OPDEF DBSO4 6546
/
/
/    DC5
/
OPDEF DBDI5 6550
OPDEF DBCI5 6553
OPDEF DBRI5 6554
OPDEF DBCO5 6555
OPDEF DBSO5 6556
/
/
/    DC6
/
OPDEF DBDI6 6560
OPDEF DBCI6 6563
OPDEF DBRI6 6564
OPDEF DBCO6 6565
OPDEF DBSO6 6566
/
/
/    AD01
/
OPDEF ADSF 6531
OPDEF ADRB 6532
OPDEF ADCV 6534
OPDEF ADSC 6535
/
/
/    DK8
/
OPDEF CLSK 6131
OPDEF CLAB 6133
OPDEF CLZE 6130
OPDEF CLDE 6132
OPDEF  CLEN 6134
OPDEF CLSA 6135
/
/
```

```
/   SPECIALS
/
OPDEF TADI 1400
OPDEF DCAI 3400
OPDEF ISZI 2400
OPDEF JMPI 5400
OPDEF ANDI 0400
OPDEF F0 6203
OPDEF KIE 6035
OPDEF RPE 6010
OPDEF TWO 7305
OPDEF GTF 6004
OPDEF RTF 6005
OPDEF JMSI 4400
OPDEF RFC 6014
OPDEF RRB 6012
OPDEF RSF 6011
OPDEF PCE 6020
/PAGE 2
/
/CALL HUD(I,J)
/
/ 0 TO DC3    I TO DC3
/ 0 TO DC4    I TO DC4
/
ENTRY HUD
HUD,BLOCK 2
TAD HUD
DCA RET1
TAD HUD#
DCA RET2
CALL 0,ARGPIC/GET I
DCA TEMP0
CALL 0,ARGPIC/GET J
DCA TEMP1
CMA
DBCO3/CLR3
CLA
TAD TEMP0
DBSO3/SET 3
CLA CMA
DBCO4/CLR THEN SET 4
CLA
TAD TEMP1
DBSO4
CLA
TAD RET2
DCA HUD#
RETRN HUD
/PAGE 3
/
```

```
/CALL DRCLR(I,J)
/
/I=Ø CLR DR5 ACCORDING TO J
/I=1 CLR DR6 ACCORDING TO J
/
ENTRY DRCLR
DRCLR,BLOCK 2
CLA IAC
DCA STCLR
TAD DRCLR
DCA RET1
TAD DRCLR#
DCA RET2
JMP DCOM
/
/CALL DRSET(I,J)
/
/I=Ø   J TO DR5
/I=1   J TO DR6
/
/ALL OTHER BIT STAY THE SAME
/
ENTRY DRSET
DRSET,BLOCK 2
CLA
DCA STCLR
TAD DRSET
DCA RET1
TAD DRSET#
DCA RET2
DCOM,CALL Ø,ARGPIC/GET I
DCA TEMPØ
CALL Ø,ARGPIC/GET J
DCA TEMP1
CALL Ø,DCLR
TAD STCLR
SZA CLA
JMP GETOUT
CALL Ø,DSET
GETOUT,TAD RET2
DCA DRSET#
RETRN DRSET
/PAGE 4
/
/J=IREAD(I)
/
/I=Ø  RETURN VALUE OF DR5
/I=1  RETURN VALUE OF DR6
/
```

```
ENTRY IREAD
IREAD,BLOCK 2
TAD IREAD
DCA RET1
TAD IREAD#
DCA RET2
CALL 0,ARGPIC
SZA CLA
JMP RDC6
DBRI5
DCA TEMP0
CMA
DBCI5/CLR AFTER READ
RRGO,CLA
TAD RET2
DCA IREAD#
TAD TEMP0
RETRN IREAD
/
RDC6,DBRI6
DCA TEMP0
CMA
DBCI6
JMP RRGO
/PAGE 5
/SUBROUTINE DSET
/
ENTRY DSET
DSET,BLOCK 2
TAD TEMP0
SZA CLA
JMP SDC6
TAD TEMP1
DBS05
SGO,CLA
RETRN DSET
SDC6,TAD TEMP1
DBS06
JMP SGO
/
/
/ SUBROUTINE DCLR
/
ENTRY DCLR
DCLR,BLOCK 2
TAD TEMP0
SZA CLA
```

```
JMP DODC6
TAD TEMP1
DBC05
DCGO,CLA
RETRN DCLR
/
DODC6,TAD TEMP1
DBC06
JMP DCGO
/PAGE 6
PAGE
/
/Y=TCH13(DUMMY)
/
/RETURN THE VALUE IN TIME
/
ENTRY TCH13
TCH13,BLOCK 2
TWO
TAD TCH13#
DCA TCH13#
/
/MULTIPLY TIME BY ONE TO NORMALIZE
/
IAC
CALL 0,FLOT
CALL 1,FMP
ARG TIME0/TIME TO FAC
DCA TIME0
DCA TIME1/0 TO TIME
DCA TIME2
RETRN TCH13
/PAGE 7
/
/I=ICH13(DUMMY)
/
/RETURN THE VALUE IN CH13
/
ENTRY ICH13
ICH13,BLOCK 2
TWO
TAD ICH13#
DCA ICH13#
TAD CH13
DCA TEMP7
DCA CH13
TAD TEMP7
RETRN ICH13
/PAGE 8
/
```

```
/I=IFLAG(DUMMY)
/
/RETURN THE VALUE IN STARTF
/
ENTRY IFLAG
IFLAG,BLOCK 2
TWO
TAD IFLAG#
DCA IFLAG#
TAD STARTF
RETRN IFLAG
/PAGE 9
/
/X=TIME(DUMMY)
/
/RETURN CLOCK IN FAC
/
ENTRY TIME
TIME,BLOCK 2
TWO
TAD TIME#
DCA TIME#
/
/MULTIPLY CLK BY ONE TO NORMALIZE
/
IAC
CALL 0,FLOT
CALL 1,FMP
ARG CLK0
RETRN TIME
/PAGE 10
CALL 1,FLOT/DUMMY CALL
GPTR,ARG GAIN
/
/
/SUBROUTINE ARGPIC
/
/PICKS UP ARGUMENTS AFTER A CALL
/
ENTRY ARGPIC
ARGPIC,BLOCK 2
TAD RET1/FIELD
DCA NEXT
NEXT,HLT
TADI RET2/PTR
DCA NGET
INC RET2
TADI RET2
```

```
DCA ARGPTR
INC RET2
NGET,HLT
TADI ARGPTR
RETRN ARGPIC
ARGPTR,0
/
/
/I=IADC(N)
/N IS THE CHANNEL (0-13)
/
ENTRY IADC
GAIN,0
1
2
3
4
5
6
7
10
/
IADC,BLOCK 2
TAD IADC
DCA RET1
TAD IADC#
DCA RET2
CALL 0,ARGPIC
TAD GPTR#/TABLE OFFSET
DCA TMPPTR
TADI TMPPTR
ADSC/SET MUX AND GO
TAD RET2
DCA IADC#
ADCW,ADSF
JMP ADCW
ADRB
RETRN IADC
/PAGE 11
PAGE
/
/INTERRUPT SERVICE ROUTINE
/
ENTRY INTER
INTER,DCA AC
GTF
DCA FLAGS
/
/
```

```
/CHECK PPT READER
/
/
JMSI PPTA/
JMP IEXT
/
/CLOCK
/
CLSK
JMP DR1
CLSA
/
/ADD 2 TO CLK
/ADDING TWO AT A TIME REDUCES ROUNDOFF
/WHEN NORMALIZING
/
CLA CLL CMA RAL
DCA SAVE
TAG,ISZ CLK2
JMP IR
ISZ CLK1
JMP IR
ISZ CLK0
SKP
HLT/BOY ARE WE IN TROUBLE
IR,ISZ SAVE/2 TIMES
JMP TAG
JMP IEXT
/
/DIGITAL CHANNEL 1
/
DR1,DBSK1
JMP DR2
DBRI1
DBCI1
DCA KEEP
TAD KEEP
CLL RAL
SNL
JMP DC11/TRY B1
/START CONDITION
CLA IAC
DCA STARTF
/START CLOCK
STCLK,CLA CMA
CLAB
CLA
TAD  ENABLE
```

```
CLDE
CLA
JMP IEXT
/
/CHECK STOP COND IF SO WAIT TILL CONT
/
DC11,RAL
SNL
JMP DC2S
CLA
CLDE/STOP CLOCK
DCWT,CLA
DBSKI
JMP DCWT
DBRI1
DBCI1
AND K1000/MUST BE CONTINUE
SNA CLA
JMP DCWT
JMP STCLK/OK RE STRT CLK
/
/CHECK BIT 8
/
DC2S,CLA
TAD KEEP
AND KK13
SNA CLA
JMP EXTN/CHECK 9-11 FOR CH13 EXT
TAD CLK0/GET TIME NOW
DCA TIME0
TAD CLK1
DCA TIME1
TAD CLK2
DCA TIME2
JMP IEXT
/
/CHECK FOR CH13 EXTENSION
/
EXTN,CLA
TAD KEEP
AND K7
CLL RAR
SNL
JMP DC2S1
CLA
DCEGO,TAD K14/14
DCA CH13
JMP IEXT
/
DC2S1,CLL RAR
SNL
JMP DC2S2
```

```
 CLA CMA
JMP DCEGO
/
DC2S2,SNA CLA
JMP IEXT
CLA IAC
JMP DCEGO
/
/DIGITAL CHANNEL 2
/
DR2,DBSK2
HLT
DBRI2
SNA
HLT
DBCI2
DCA KEEP
CLA CLL
DCA CHI3
TAD KEEP
AGAIN,ISZ CHI3
RAL
SNL
JMP AGAIN
IEXT,CLL CLA
TAD FLAGS
RTF
CLA
TAD AC
JMPI 0
/
AC,0
FLAGS,0
KEEP,0
ENABLE,5210
K1000,1000
K7,7
KK10,10
K14,16
CALL 1,FLOT
PPTA,ARG HPPT
/PAGE 12
PAGE
/
/CALL INIT
/
ENTRY INIT
ABSYM IVECTI 1
```

```
ABSYM IVECT2 2
CALL 1,FLOT/DUMMY
IPTR,ARG INTER
KEXP,2320
K5402,5402
/
INIT,BLOCK 2
TAD K5402
DCA IVECT1
TAD IPTR#
DCA IVECT2
TAD KEXP
DCA CLK0
DCA CLK1
DCA CLK2
DCA CH13
DCA TIME0
DCA TIME1
DCA TIME2
DCA PTFLG
DCA STARTF
DBEI1
DBEI2
DBDI3
DBDI4
DBDI5
DBDI6
KIE
PCE
CMA
DBCI1
DBCI2
DBCO3
DBCO4
DBCI5
DBCO5
DBCI6
DBCO6
CLA
ION
RETRN INIT
/
/ CALL RPPT(ARRAY)
/
ENTRY RPPT
RPPT,BLOCK 2
TAD RPPT
DCA RUN
RUN,0
```

```
TADI RPPT#/FIELD
DCA F1
INC RPPT#
TADI RPPT#/ADD
DCA PTSTAT
INC RPPT#
TAD PTSTAT
IAC
DCA PTPTR
TAD F1
DCA F2
TAD F1
DCA RNX1
RNX1,0
DCAI PTSTAT
F0
IAC
DCA PTFLG
RFC
RPE
RETRN RPPT
/
/
/INTERRUPT HANDLER
/
HPPT,0
RSF
JMP NOSKP
RRB
AND K77
DCA SPPT
TAD PTFLG
SNA CLA
JMP GOBACK#
TAD SPPT
TAD M72
SPA
JMP MCHK
SZA CLA
JMP GOBACK
/
/GOT A : SO STOP
/
DCA PTFLG
F1,0
IAC
DCAI PTSTAT
```

```
TAD SPPT
DCAI PTPTR
PCE
JMP GOBACK/
/
MCHK,TAD KK14
SMA
JMP COK/CHARACTER IS GOOD
/
/LAST CHANCE IT COULD BE A SPACE (240)
/
TAD K16
SZA CLA
JMP GOBACK
/
/SUBSTITUTE WITH A 0
/
TAD K60
JMP F2
COK,CLA
TAD SPPT
F2,0
DCAI PTPTR
ISZ PTPTR
GOBACK,RFC
CLA
F0
JMPI HPPT
NOSKP,ISZ HPPT
JMPI HPPT
SPPT,0
K77,77
KK14,14
M72,-72
K60,60
K16,16
END
```

C. HP2100 FORTRAN PROGRAM FOR DATA TRANSFER

```
FTN4,L
      PROGRAM VDATA
      DIMENSION INAM(3)
      DIMENSION IN(5,8),SUM(5,8),IPK(5,8),J(1),NFILE(3),IDCB(144)
      DIMENSION IANS(2),MI(1),L(1),IBUF1(1)
      DIMENSION BUF1(1),IBUF2(1),INDX(1),INAME(3)
      DIMENSION LDET(1),JDB(1),TT(1)
      DATA INAM/2HVI,2HND,2HX /
C
C
C THIS PROGRAM WILL READ VDC INPUT DATA FROM PAPER TAPE AND
C CREATE A DISK FILE NAMED VXXXX(WHERE XXXX IS THE SUBJECTS
C NUMBER) THAT CONTAINS THE RECEIVED DATA. IT WILL ALSO CREATE
C A MAG TAPE FILE FOR THIS DATA WITH THE FIRST RECORD OF THE
C MAG TAPE FILE CONTAINING THE NAME VXXXX. DISK FILE VINDX IS
C AN INDEX FILE FOR THE MAG TAPE AND CONTAINS THE FILE NUMBER
C FOR EACH SUBJECT VXXXX.  THIS INDEX FILE IS ALSO WRITTEN AS
C THE LAST FILE ON THE MAG TAPE.
C
C
      K=0
      IOPT=2B
      IOPTN=  2B
      IBELL=7B
      IERAS=15412B
5     WRITE(1,10)
10    FORMAT("CHECK YOUR MAG TAPE !!!",/,
     C"THE TAPE MUST BE AT LOAD POINT AND WRITE ENABLED.",/,
     C"IS THE MAG TAPE READY ? YES OR NO")
      WRITE(1,30)IBELL
30    FORMAT(A2)
      READ(1,20)IANS
20    FORMAT(2A2)
      WRITE(1,30)IERAS
      IF(IANS.EQ.2HNO)GO TO 5

C OPEN THE DISK FILE CONTAINING THE MAG TAPE INDEX
35    CALL OPEN(IDCB,IERR,INAM,IOPT )
      IF(IERR.LT.0)GO TO 190

C SET UP THE FILE COUNTER FOR THE MAG TAPE ADVANCING
      J=1
40    CALL READF(IDCB,IERR,INDX)
      IF(IERR.LT.0)GO TO 190
      IF(INDX.NE.0)J=J+1
      IF(INDX.NE.0) GO TO 40
      IF(J.EQ.1)GO TO 60
```

```
      IF(K.EQ.1)GO TO 61
C ADVANCE MAG TAPE TO START OF INDEX FILE
      JJ=J-1
      DO 50 KK=1,JJ
50    CALL EXEC(3,13103)
      IF(J.NE.1)GO TO 61
60    CALL CLOSE(IDCB,IERR)
      IF(IERR.LT.0)GO TO 190
      CALL OPEN(IDCB,IERR,INAM,IOPT )
      IF(IERR.LT.  0)GO TO 190
      GO TO 65
61    CALL CLOSE(IDCB,IERR)
      IF(IERR.LT.0)GO TO 190
      CALL OPEN(IDCB,IERR,INAM,IOPT )
      IF (IERR.LT.0)GO TO 190
      JJ=J-1
      DO 62 II=1,JJ
62    CALL READF(IDCB,IERR,INDX)
      IF(IERR.LT.0)GO TO 190
65    WRITE(1,70)
70    FORMAT("ENTER THE SUBJECTS NUMBER AS [illegible]",/,
     C"DESIGNATES A [illegible] SUBJECT AND YYYY IS THE 4 DIGIT",/,
     C"SUBJECT NUMBER.")
      READ(1,[illegible])NFILE
[illegible] FORMAT(3A2)
C [illegible]ATE THE INDEX FILE WITH [illegible] SUBJECT INF.
      CALL WRITF(I[illegible],IERR,J,[illegible])
      IF(IE[illegible].LT.[illegible]) [illegible]
      J=[illegible]
      CALL WRITF(ID[illegible],I[illegible],J,[illegible]
      IF(IER[illegible].LT.0)GO TO 190
      WRITE(-,[illegible])NFILE
[illegible]
      CALL [illegible]
      IF(I[illegible].LT.[illegible]
      CALL [illegible]AT(IDC[illegible],I[illegible],NFIL[illegible],-1,[illegible]
      IF(I[illegible].LT.[illegible]) [illegible]
      CALL [illegible]
      IF(I[illegible].LT.[illegible]
      CALL [illegible]
      IF(I[illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
[illegible]
      [illegible]
[illegible]
      [illegible]
```

```
      BUF1=SUM(L,M1)
      IBUF2=IPK(L,M1)
100   CALL WRITF(IDCB,IERR,M1,10)
      IF(IERR.LT.0)GO TO 190
110   READ(5,120)LDET,JDR,TT
120   FORMAT(3X,2I4,F20.3)
      IF(LDET.EQ.-9)GO TO 130
      WRITE(8,120)LDET,JDR,TT
      CALL WRITF(IDCB,IERR,LDET,8)
      IF(IERR.LT.0)GO TO 190
      GO TO 110
130   CALL WRITF(IDCB,IERR,LDET,5)
      IF(IERR.LT.0)GO TO 190
      CALL LOCF(IDCB,IERR,I,IRB,I,JSEC)
      IF(IERR.LT.0)GO TO 190
      ITRUN=JSEC/2-IRB-1
      CALL CLOSE(IDCB,IERR,ITRUN)
      IF(IERR.LT.0)GO TO 190
      WRITE(1,140)
140   FORMAT("DO YOU WANT TO ENTER MORE SUBJECTS TO THIS",/,
     C"FILE ?? YES OR NO")
      WRITE(1,30)IBELL
      CALL EXEC(3,110B)
      READ(1,20)IANS
      WRITE(1,30)IERAS
      IF(IANS.EQ.2HNO)GO TO 150
      K=1
      GO TO 35
150   CALL OPEN (IDCB,IERR,INAM,IOPT )
      IF(IERR.LT.0)GO TO 190
160   CALL READF(IDCB,IERR,INDX)
       IF(IERR.LT.0)GO TO 190
      IF(INDX.EQ.0)GO TO 180
      WRITE(8,170)INDX,INAME
170   FORMAT(I4,3A2)
      GO TO 160
180   CALL EXEC(3,110B)
      CALL EXEC(3,410B)
      CALL CLOSE(IDCB,IERR)
      IF(IERR.LT.0)GO TO 190
      GO TO 210
190   WRITE(1,200)IERR
200   FORMAT("FMP ERROR #  ",I4)
      CALL CLOSE(IDCB)
210   END
      ENDS
```

```
FTN4,L
      PROGRAM READD
      DIMENSION IN(5,8),SUM(5,8),IPK(5,8),J(1),NFILE(3),IDCB(144)
      DIMENSION IANS(2),MI(1),L(1),IBUF1(1)
      DIMENSION BUF1(1),IBUF2(1),INDX(1),INAME(3),INAM(3)
      DIMENSION LDET(1),JDR(1),TT(1)
      DATA INAM/2HVI,2HND,2HX /
      IBELL=7B
      IOPTN=110B
      IERAS=15414B
      WRITE(1,10)
10    FORMAT("ENTER FILE NAME TO BE READ")
      READ(1,20)INAME
20    FORMAT(3A2)
      CALL OPEN(IDCB,IERR,INAME,IOPTN)
      DO 40 I=1,40
30    CALL READF(IDCB,IERR,MI)
      WRITE(1,50)MI,L,IBUF1,BUF1,IBUF2
50    FORMAT(2X,2I2,I4,E13.5,I4)
40    CONTINUE
55    CALL READF(IDCB,IERR,LDET)
      IF(LDET.EQ.-9)GO TO 60
      WRITE(1,45)LDET,JDR,TT
45    FORMAT(2I4,F20.3)
      GO TO 55
60    CONTINUE
      END
      END$


FTN4,L
      PROGRAM READV
      DIMENSION IN(5,8),SUM(5,8),IPK(5,8),J(1),NFILE(3),IDCB(144)
      DIMENSION IANS(2),MI(1),L(1),IBUF1(1)
      DIMENSION BUF1(1),IBUF2(1),INDX(1),INAME(3),INAM(3)
      DATA INAM/2HVI,2HND,2HX /
      IBELL=7B
      IERAS=15414B
C OPEN THE DISK FILE CONTAINING THE MAG TAPE INDEX
35    CALL OPEN(IDCB,IERR,INAM)
      DO 20 I=1,100
5     CALL READF(IDCB,IERR,J)
      IF(J.EQ.0)I=100
      WRITE(1,15)J,NFILE
15    FORMAT(I2,3A2)
20    CONTINUE
10    CONTINUE
      CALL CLOSE (IDCB)
      END
      END$
```

VDS DIGITAL I/O SIGNALS

I. SIGNAL DESCRIPTION

A. START

1. Source - - Supervisor's Panel
2. Destination - - PDP 8/e
3. I/O - - DC 50, J2-0
4. Activated by supervisor at start of experiment
5. Input must go from +5 VDC to 0 VDC when START button is pushed (momentary grounding of open line)
6. Jumper AB must be installed in position 00 of DC 50 for edge detection
7. Interrupt jumper not connected

B. STOP

1. Source - Supervisor Panel
2. Destination PDP 8/e
3. I/O - - DC 50, J2-1
4. Activated by supervisor to stop experiment
5. Input must go from +5 VDC to 0 VDC when STOP button is pushed (momentary grounding of open line)
6. Jumper AB must be installed in position 01 of DC 50 for edge detection
7. Interrupt jumper connected

C. CONTINUE

1. Source Supervisor's Panel
2. Destination PDP 8/e
3. I/O DC 50, J2-2
4. Activated by Supervisor to continue experiment after a STOP

5 6 7 Same as for 5, 6 and 7 above

D. SUSPEND

1. Source Supervisor's Panel
2. Destination PDP 8/e
3. I/O DC 55, J2 1
4. A two position toggle switch activated by supervisor to temporarily stop the advance of the slides and sampling of the analog signals from the GAT
5. A true input selects suspend and must be low (0 VDC) A false input must be high (+5 VDC)
6. Jumper BC must be installed in position 01 of DC 55 for level detection
7. Interrupt jumper not connected (programmed sampled)

E. DETECT SECTORS 1 - 14

1. Source - GAT - 1 Cockpit
2. Destination - - PDP 8/e
3. I/O - DC 51; J2-0 thru J2-11 and DC 50, J2-10, J2-11
4. One of 14 input lines activated by pilot at time of detection
5. Input must go from +5 VDC to 0 VDC when line is activated (momentary grounding of open line)
6. Jumper AB must be installed in all 14 positions for edge detection
7. All corresponding interrupt jumpers must be connected
8. Minimum time between successive inputs is on the order of a few seconds

F DETECT BUTTON FROM GAT

1. Source GAT 1 Cockpit
2. Destination PDP 8 e
3. I/O DC 50, J2 8
4. Activated by pilot to indicate a target
5. Input must go from +5 VDC to 0 VDC when line is activated (momentary grounding of open line)
6. Jumper AB must be installed in position 08 of DC 50 for edge detection
7. Interrupt jumper connected

G DETECT ERROR

1. Source Supervisor's Console
2. Destination PDP 8 e
3. I O DC 50 J2 9
4. Activated by supervisor to indicate an error in selected detection sector
5. Input must go from +5 VDC to 0 VDC when line is activated (momentary grounding of open line)
6. Jumper AB must be installed in position 09 of DC 50 for edge detection
7. Interrupt jumper connected

H AIRSPEED 1 2

1. Source Supervisor's Panel
2. Destination PDP 8 e
3. I O DC 55 J2 0 and J2 5
4. A two position toggle switch set by the supervisor
5. Active (true) input line must be at ground level (0 VDC) while the other line will have a false input of +5 VDC. Only one of the inputs can be true at one time
6. Jumper BC must be connected in positions 00 and 04 of DC 55 for level detection
7. Interrupt jumpers not connected (programmed sampled)

I. ALTITUDE 1 - 5

1. Source - - Supervisor's Panel
2. Destination - - PDP 8/e
3. I/O - - DC 55; J2-6 thru J2-10
4. A six position rotary switch which determines the altitude reference value. One of five input lines has a true input to denote one of the six reference altitudes selected by the supervisor
5. Active (true) input line must be at ground level (0 VDC). All other lines must have high (false) inputs (+5 VDC). Only one of five inputs can be true at same time
6. Jumper BC must be connected in positions 06 thru 10 of DC 55 for level detection
7. Interrupt jumpers not connected (programmed sampled)

J IFR/VFR

1. Source - - Supervisor' Panel
2. Destination - - PDP 8/e
3. I/O - - DC 55, J2-11
4. A two-position toggle switch activated by supervisor to determine which altitude has been referenced. Each of the six altitude references can have two values and the IFR/VFR switch determines which has been selected
5. A true input selects VFR and must be low (0 VDC). A false input selects IFR and must be high (+5 VDC)
6. Jumper BC must be connected in position 11 of DC 55 for level detection
7. The interrupt jumper not connected (programmed sampled)

K. LEVEL-CLIMB

1. Source - Supervisor Panel
2. Destination - PDP 8/e
3. I/O DC 56, J2-11
4. A two-position toggle switch activated by supervisor to determine whether true altitude sampled from the GAT should be compared to the altitude references switches or if the rate of climb analog value should be compared to a programmed + 500 ft/min for the figure of merit computations
5. A true input selects CLIMB and must be low (0 VDC). A false input selects LEVEL and must be high (+5 VDC)
6. Jumper BC must be connected in position 11 of DC 56 for level detection
7. The interrupt jumper not connected (programmed sampled)

L. DG/VOR

1. Source - - Supervisor's Panel
2. Destination - - PDP 8/e
3. I/O - - DC 56; J2-0
4. Set to either DG or VOR by supervisor to indicate interpretation of "ANGLE" input (see below); and to indicate selection of either heading or VOR error calculations in "figure-of-merit" computations
5. A true input selects DG and must be low (0 VDC). A false input selects VOR and must be high (+5 VDC)
6. Jumper BC must be connected in position 00 of DC 56 level detection (programmed sampled)
7. The interrupt jumper not connected

M. ANGLE

1. Source - - Supervisor's Panel
2. Destination - - PDP 8/e
3. I/O - - DC 56, J2-1 thru J2-10
4. Communicates command heading selected by the supervisor to the PDP 8/e for figure-of-merit computations
5. Ten lines are assigned to accomodate BCD-encoded angles in the range from 0 to 360^{0} True inputs are low (0 VDC) and false inputs are high (+5 VDC)
6. Jumper BC must be installed in positions 01 through 10 of DC 56 for level detection
7. Interrupt jumpers not connected (programmed sampled)

N. SKIP ODD

1. Source - - PDP 8/e
2. Destination - - Projection Sub-System
3. I/O - - DC 56, J1-9
4. A single line is provided to control slide skips in the odd set of projectors and is program controlled
5. A true output (0 VDC) will be provided for a duration of .8 second for a single slide skip Multiple slide skips will be controlled by a succession (3 max) of single slide skip signals spaced by at least one second

O. SKIP EVEN

1. Source PDP 8/e
2. Destination Projection Sub-System
3. I/O DC 56, J1-8
4. A single line is provided to control slide skips in the even set of projectors and is program controlled
5. Same as (5) above

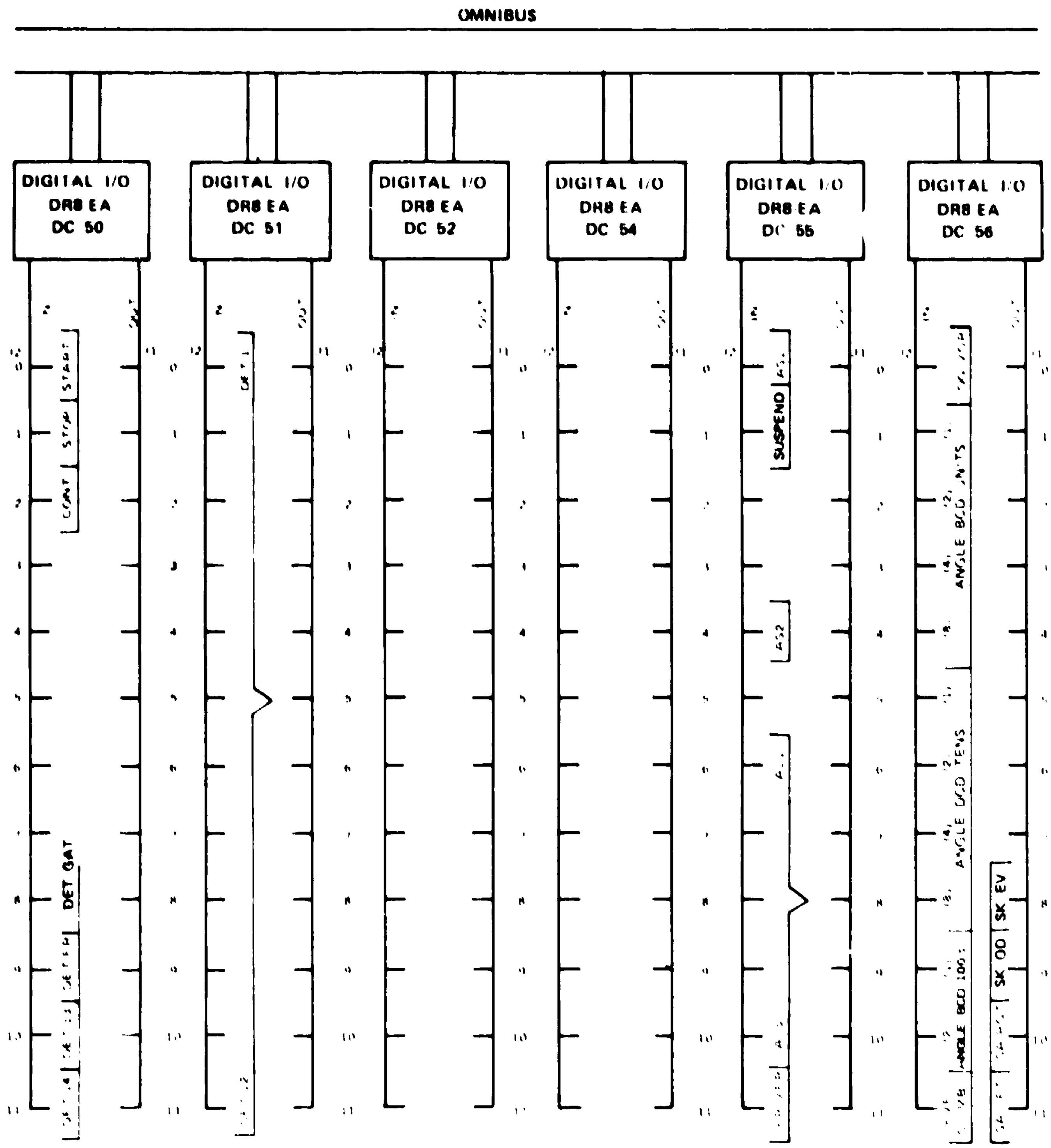
P. SLIDE ADVANCE RIGHT

1. Source - - PDP 8/e
2. Destination - - Projection Sub-System
3. I/O - - DC 56; J1-10
4. The signal on this line controls normal single slide advances for the right half of the series. This signal advances the ON-projector set by one slide, and gradually removes power from the ON-set while applying power to the OFF-set
5. A true signal having a duration of .8 second will be provided for each advance and is under program control

Q. SLIDE ADVANCE LEFT

1. Source - - PDP 8/e
2. Destination - - Projection Sub-System
3. I/O - - DC 56; J1-11
4, 5. Same as 4 and 5 above except the control is on the left half of the projector series

II. COMPUTER DIGITAL I/O INTERFACES



III. COMPUTER CHECK OF THE DIGITAL I/O SIGNALS

Two similar programs have been developed for checking the digital inputs and outputs used by the VDS. The program, M863 Digital Board Check-out, is designed specifically for testing the M863 card only and does not check the digital input or output circuitry of peripheral devices interfaced with the computer. For the M863 Check-out, the output pots serve as inputs and are compared in order to ascertain if the board is functioning properly. To effectively use this program, some expertise is required with ODT (Octal Debugging Technique for the PDP 8/e) and computer hardware skills.

The second program, I/O Digital Interface Check-out, requires minimal computer skills and can be used to check the complete circuitry of the digital inputs. This program requires that the channel number of interest be placed in the switch register and the corresponding devise be activated (e.g., button pushed) for comparison. If an error is detected, it will be necessary to run M863 Digital Board Check-out to determine if the problem is on the interface board or elsewhere in the circuit.

A. M863 DIGITAL BOARD CHECK-OUT

1. Procedures

Step 1. Cable the input and output ports of the card(s) together

Step 2. Load ODT (high) and the M863 Digital Board Check-out program

Step 3. Specify the device code of card under test in location 321 using ODT. The device code is in the form of OXXO where XX is the octal number of the device address (See Section V, Part II). Location 321 is the content of A340

Step 4. Start the program with ODT. Starting address is 300

Step 5. When an error is found, control is given to ODT for trouble shooting purposes. If no error is found, the program continues checking the card until the computer is halted.

Step 6. To check another card repeat steps 3, 4, and 5

2. Program Listing

M863 DIGITAL BOARD CHECK-OUT

```
*200
START,  JMS INIT
        TAD NUM
        DCA MUN
        TAD MUN
        DBSO
        CLA CLL
        DBRI
        DCA TEMP
        JMS INIT
        TAD TEMP
        CMA IAC
        TAD MUN
        SZA CLA
        JMP I ODT
        TAD MUN
        CLL RAL
        DCA MUN
        JMP START+3
INIT,   Ø
        NOP
        CLA CMA
        DBCI
        DBCO
        DBDI
        CLA CLL
        JMP I INIT
ODT,    7300
NUM,    1
MUN,    Ø
TEMP,   Ø
        DBCI=6503
        DBCO=6505
        DBDI=650Ø
        DBSO=6506
        DBRI=6504
*300
BEG,    CLA CLL
        TAD A34Ø
        TAD A341
        DCA INIT+3
        TAD A34Ø
        TAD A342
        DCA INIT+4
        TAD A343
        TAD A342
        DCA INIT+5
        TAD A34Ø
```

```
        TAD A344
        DCA START+4
        TAD A340
        TAD A345
        DCA START+6
        JMP START
A340,   0
A341,   6003
A342,   6005
A343,   6000
A344,   6006
A345,   6004
$
```

3. I/O DIGITAL INTERFACE CHECK OUT

1. Procedures

Step 1. Load the program I/O Digital Interface Check-out. [Follow Steps A, B, C, and D of Appendix D, Part II. For Step D substitute this program for the Linking Loader.]

Step 2. Deposit 0500_8 in location 316_8. [Set the switch register keys to 316_8, press address load. Then put 500_8 in the switch register, pull up momentarily on the switch DEP.] The middle two digits of 0500_8 is the I/O digital card number.

Step 3. Start the program at location 300_8.

Step 4. The computer will immediately halt.

Step 5. Put 7407_8 in the switch register. These are the input channels used on card 50.

Step 6. Press the following keys on the instructor's console: START, STOP, CONT, DET ER, DET 13, DET 14. Also push the detect button in the GAT-1.

Step 7. Press CONTINUE on the computer console.

Step 8. The computer will halt immediately. If the accumulator contents equal zero, all the channels check out properly. Otherwise the contents indicate which channel is malfunctioning. (See Section V, Part II.)

Step 9. Repeat Steps 2 through 8 with the following changes: deposit 0510_8 in location 316_8, put 7777_8 in the switch register, press buttons DET 1 through DET 12.

Step 10. Deposit 0550_8 in location 316_8 and start the program.

Step 11. Place the toggle switches on the supervisor's console in the following positions: VFR, SUSPEND, 95 MPH. Put the altitude switch in the 0/0 position and 6041_8 in the switch register. To check this card, it is imperative that the altitude switch be changed appropriately for the contents of the accumulator to be meaningful.

Step 12. Press CONTINUE. The accumulator contents should equal zero.

Step 13. Start the program. Change airspeed switch to 115 MPH and altitude switch to 1000/2000. Put 2221_8 in the switch register, press CONTINUE. Accumulator should equal zero.

Step 14. Repeat Step 13 only change the altitude switch to 2500/3000 and put 2211_8 in the switch register.

Step 15. Repeat Step 13 wtih the altitude switch at 3500/4000 and put 2205_8 in the switch register.

Step 16. Repeat Step 13 with the altitude switch at 4500/5000 and put 2203_8 in the switch register.

Step 17. Deposit 0560_8 in location 316_8 and start the program.

Step 18. Put 4001_8 in the switch register. Put the LEVEL/CLIMB switch to CLIMB and the DG/VOR to DG. Set the thumbwheel switches to a heading of 000. Press CONTINUE and check the accumulator. If the contents of the accumulator is not equal to zero, some familiarity with the program and circuitry is required to determine which channel is malfunctioning.

Step 19. Start the program. Put 6105 in the switch register and set in a heading of 111. Press CONTINUE, check the accumulator.

Step 20. Repeat Step 19 with a heading of 222 and 5043_8 in the switch register.

Step 21. Repeat Step 19 with a heading of 244 and 4423_8 in the switch register.

Step 22. Repeat Step 19 with a heading of 288 and 4213_8 in the switch register.

2. Program Listing

```
*200
START,  JMS INIT
        HLT
        LAS
        DCA MUN
        CLA CLL
        DBRI
        DCA TEMP
        JMS INIT
        TAD TEMP
        CMA IAC
        TAD MUN
        SZA
        HLT
        DCA TEMP
        JMP START
INIT,   0
        NOP
        CLA CMA
        DBCI
        DBCO
        DBDI
        CLA CLL
        JMP I INIT
ODT,    7000
NUM,    0
MUN,    0
TEMP,   0
        DBCI=6503
        DBCO=6505
        DBDI=6500
        DBSO=6506
        DBRI=6504
*300
BEG,    CLA CLL
        TAD A340
        TAD A341
        DCA INIT+3
        TAD A340
        TAD A342
        DCA INIT+4
        TAD A343
        TAD A340
        DCA INIT+5
        TAD A340
        TAD A345
        DCA START+5
```

```
        JMP START
A340,   0
A341,   6003
A342,   6005
A343,   6000
A344,   6006
A345,   6004
$
```

IV. DIGITAL SIGNAL FLOW

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE		DESTINATION
START		S29-PA1 S27-PB1	L L	DC50:J2-0
STOP		S29-PC1 S27-PD2	L L	DC50:J2-1
CONT		S29-PB1 S27-PD1	L L	DC50:J2-2
DETECT (DET)	PUSHBUTTON IN GAT-1	COAX S27-PJ1	L L	DC50 J2-8
DET ERR	PUSHBUTTON ON SP	S29-PD2 S27-PM2	L L	DC50 J2-9
DET SECT 13	PUSHBUTTON ON SP	S29 PD1 S27 PL1	L L	DC50:J2-10
DET SECT 14	PUSHBUTTON ON SP	S29-PE1 S27-PP2	L L	DC50 J2-11
DET SECT 1	PUSHBUTTON ON SP	S29-PE2 S28-PB1	L L	DC51 J2-0
DET SECT 2	PUSHBUTTON ON SP	S29-PH1 S28-PD2	L L	DC51 J2-1
DET SECT 3	PUSHBUTTON ON SP	S29 PF2 S28 PD1	L L	DC51 J2 2
DET SECT 4	PUSHBUTTON ON SP	S29-PJ1 S28-PE2	L L	DC51 J2 3
DET SECT 5	PUSHBUTTON ON SP	S29-PH2 S28-PE1	L L	DC51 J2-4
DET SECT 6	PUSHBUTTON ON SP	S29-PK1 S28 PH2	L L	DC51 J2-5
DET SECT 7	PUSHBUTTON ON SP	S29-PJ2 S28-PH1	L L	DC51 J2-6
DET SECT 8	PUSHBUTTON ON SP	S29-PL2 S28 PK2	L L	DC51 J2 7
DET SECT 9	PUSHBUTTON ON SP	S29 PK2 S28 PJ1	L L	DC51 J2-8
DET SECT 10	PUSHBUTTON ON SP	S29 PM2 S28 PM2	L L	DC51 J2 9
DET SECT 11	PUSHBUTTON ON SP	S29 PM1 S28 PL1	L L	DC51 J2 10
DET SECT 12	PUSHBUTTON ON SP	S29-PN1 S28 PP2	L L	DC51 J2 11

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE		DESTINATION
AIRSPEED 1 95 MPH	TOGGLE SW ON SP	S30-PA1 S31-PB1	L L	DC55 J2-0
SUSPEND	TOGGLE SW ON SP	S30-PC1 S31-PD2	L L	DC55 J2-1
		S30-PB1 S31-PD1	L L	DC55 J2-2
		S30-PD2 S31-PE2	L L	DC55 J2-3
AIRSPEED 2 115 MPH	TOGGLE SW ON SP	S30-PD1 S31-PE1	L L	DC55 J2-4
		S30-PE2 S31-PH2	L L	DC55 J2-5
ALTITUDE 1 0/0	ROTARY SW ON SP	S30-PE1 S31-PH1	L L	DC55 J2-6
ALTITUDE 2 1000/2000	ROTARY SW ON SP	S30-PH1 S31-PK2	L L	DC55 J2-7
ALTITUDE 3 2500/3000	ROTARY SW ON SP	S30-PF2 S31-PJ1	L L	DC55 J2-8
ALTITUDE 4 3500/4000	ROTARY SW ON SP	S30-PJ1 S31-PM2	L L	DC55 J2-9
ALTITUDE 5 4500/5000	ROTARY SW ON SP	S30-PH2 S31-PL1	L L	DC55 J2-10
VFR IFR	TOGGLE SW ON SP	S30-PJ2 S31-PP2	L L	DC55 J2-11
	DC55 J1-0	S59-PB1 S52-PR2 S52-PR1 S56-PR2	L L I I	
	DC 55 J1-1	S59-PD2 S52-PS2 S52-PS1 S56-PS1	L L I I	
	DC55 J1-2	S59-PD1 S53-PR2 S53-PR1 S56-PS2	L L I I	
	DC55 J1-3	S59-PE2 S53-PS2 S53-PS1 S56-PT2	L L I I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE	DESTINATION
	DC55 J1 4	S59 PE1 L S54 PR2 L S54 PR1 I S56 PU1 I	
	DC55 J1 5	S59 PH2 L S54 PS2 L S54 PS1 I S56 PU2 I	
CG VOP	TOGGLE SW ON SP	S32 PB1 L S30 PK1 L	DC56 J2 0
ANGLE BCD UNITS (2⁰)	THUMBWHEEL SW ON SP	S32 PD2 L S30 PL2 L	DC56 J2 1
ANGLE BCD UNITS (2¹)	THUMBWHEEL SW ON SP	S32 PD1 L S30 PK2 L	DC56 J2 2
ANGLE BCD UNITS (2²)	THUMBWHEEL SW ON SP	S32 PE2 L S30 PM2 L	DC56 J2 3
ANGLE BCD UNITS (2³)	THUMBWHEEL SW ON SP	S32 PE1 L S30 PM1 L	DC56 J2 4
ANGLE BCD TENS (2⁰)	THUMBWHEEL SW ON SP	S32 PH2 L S30 PN2 L	DC56 J2 5
ANGLE BCD TENS (2¹)	THUMBWHEEL SW ON SP	S32 PH1 L S30 PN1 L	DC56 J2 6
ANGLE BCD TENS (2²)	THUMBWHEEL SW ON SP	S32 PK2 L S30 PR1 L	DC56 J2 7
ANGLE BCD TENS (2³)	THUMBWHEEL SW ON SP	S32 PJ1 L S30 PP2 L	DC56 J2 8
ANGLE BCD 100's (2⁰)	THUMBWHEEL SW ON SP	S32 PM2 L S30 PS1 L	DC56 J2 9
ANGLE BCD 100's (2¹)	THUMBWHEEL SW ON SP	S32 PL1 L S30 PR2 L	DC56 J2 10
	DC56 J1 0	S60 PB1 L S51 PR2 L S51 PR1 I S56 PV1 I	
LEVEL CLIMB	TOGGLE SW ON SP	S32 P2 L S30 S2 L	DC56 J2 11

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE		DESTINATION
SK EVEN	DC56 J1-8	S60 PJ1	L	PROJECTION SYSTEM
		S48 PV1	L	
		S48 PU1	H	
		S64 PJ2	H	
		S64 PS2	I	
		S62 H2	I	
		S62 PD2 S30 PT2	COMM	
		S62 PE2 S30 PU2	NO	
SK ODD	DC56 J1 9	S60 PM2	L	PROJECTION SYSTEM
		S48 PS2	L	
		S48 PT2	H	
		S63 PJ2	H	
		S63 PS2	I	
		S62 PJ2	I	
		S62 PL2 S30 PT2	COMM	
		S62 PM2 S30 PP1	NO	
SL ADV RGT	DC56 J1 10	S60 PL1	L	PROJECTION SYSTEM
		S48 PR1	L	
		S48 PS1	H	
		S63 PD2	H	
		S63 PR2	I	
		S61 PJ2	I	
		S61 PL2 S30 PT2	COMM	
		S61 PM2 S30 PV1	NO	
SL ADV LFT	DC56 J1 11	S60 PP2	L	PROJECTION SYSTEM
		S48 PU2	L	
		S48 PV2	H	
		S64 PD2	H	
		S64 PR2	I	
		S61 PH2	I	
		S61 PD2 S30 PT2	COMM	
		S61 PE2 S30 PU1		

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE		DESTINATION
	DC52:J1-0	S5-PB1	L	S6-S10 & S38-S42-PIN A1 (LOW)
	DC52:J1-1	S5-PD2	L	S6-S10 & S38-S42-PIN D1 (LOW)
	DC52:J1-2	S5-PD1	L	S6-S10 & S38-S42-PIN H1 (LOW)
	DC52:J1-3	S5-PE2	L	S6-S10 & S38-S42-PIN L1 (LOW)
	DC52:J1-4	S5-PE1	L	S6-S10 & S38-S42-PIN P1 (LOW)
	DC52:J1-5	S5-PH2	L	S6-S10 & S38-S42-PIN D2 (LOW)
	DC52:J1-6	S5-PH1	L	S6-S10 & S38-S42-PIN H2 (LOW)
	DC52:J1-7	S5-PK2	L	S6-S10 & S38-S42-PIN L2 (LOW)
	DC52:J1-8	S5-PJ1	L	S6-S10 & S38-S42-PIN P2 (LOW)
	DC52:J1-9	S5-PM2	L	S6-S10 & S38-S42-PIN T2 (LOW)
	DC54:J1-0	S37-PB1	L	S6-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-1	S37-PD2	L	S7-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-2	S37-PD1	L	S8-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-3	S37-PE2	L	S9-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-4	S37-PE1	L	S10-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-5	S37-PH2	L	S38-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-6	S37-PH1	L	S39-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-7	S37-PK2	L	S40-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-8	S37-PJ1	L	S41-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)
	DC54:J1-9	S37-PM2	L	S42-PINS B1, E1, J1, M1, R1, E2, J2, M2, R2 & U2 (LOW)

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE		TEST POINTS AND LEVELS FOR TRUE		DESTINATION
	S6-PC1	H	S12-PC1	H	
			S12-PD2	L	
			S18-PD2	L	
			S18-PD1(END)	I	
			S P	I	
	S6-PF1	H	S12 PD1	H	
			S12 PE1	L	
			S18 PE2	L	
			S18 PE1(END)	I	
			S P		
	S6-PK1	H	S12 PE2	H	
			S12 PF2	L	
			S18 PF2	L	
			S18 PF1(END	I	
			S P		
	S6-PN1	H	S12 PF1	H	
			S12-PH1	L	
			S18 PH2	L	
			S18 PH1(END	I	
			S P		
	S6-PS1	H	S12 PH2	H	
			S12 PJ2	L	
			S18 PJ2	L	
			S18 PJ1(END	I	
			S P		
	S6 PF2	H	S12 PJ1	H	
			S12 PK1	L	
			S18 PK2	L	
			S18 PK1 END	I	
			S P		
	S6-PK2	H	S12 PK2	H	
			S12 PL2	L	
			S18 PL2	L	
			S18 PL1	I	
			S24 PA1	I	
	S6-PN2	H	S12 PL1	H	
			S12 PM1	L	
			S18 PM2	L	
			S18 PM1	I	
			S24 PB1	I	
	S6-PS2	H	S12 PM2	H	
			S12 PN2	L	
			S18 PN2	L	
			S18-PN1	I	
			S24-PC1	I	
	S6-PV2	H	S12 PN1	H	
			S12 PP1	L	
			S18 PP2	L	
			S18-PP1	I	
			S24 PD1	I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE	DESTINATION
	S7-PC1 H	S13-PC1 H S13-PD2 L S19-PD2 L S19-PD1 I S24-PD2 I	
	S7-PF1 H	S13-PD1 H S13-PE1 L S19-PE2 L S19-PE1 I S24-PE1 I	
	S7-PK1 H	S13-PE2 H S13-PF2 L S19-PF2 L S19-PF1 I S24-PE2 I	
	S7-PN1 H	S13-PF1 H S13-PH1 L S19-PH2 L S19-PH1 I S24-PF1 I	
	S7-PS1 H	S13-PN2 H S13-PJ2 L S19-PJ2 L S19-PJ1 I S24-PF2 I	
	S7-PF2 H	S13-PJ1 H S13-PK1 L S19-PK2 L S19-PK1 I S24-PH1 I	
	S7-PK2 H	S13-PK2 H S13-PL2 L S19-PL2 L S19-PL1 I S24-PH2 I	
	S7-PN2 H	S13-PL1 H S13-PM1 L S19-PM2 L S19-PM1 I S24-PJ1 I	
	S7-PS2 H	S13-PM2 H S13-PN2 L S19-PN2 L S19-PN1 I S24-PJ2 I	
	S7-PV2 H	S13-PN1 H S13-PP1 L S19-PP2 L S19-PP1 I S24-PK1 I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE		TEST POINTS AND LEVELS FOR TRUE		DESTINATION
	S8-PC1	H	S14-PC1	H	
			S14-PD2	L	
			S20-PD2	L	
			S20-PD1	I	
			S24-PK2	I	
	S8-PF1	H	S14-PD1	H	
			S14-PE1	L	
			S20-PE2	L	
			S20-PE1	I	
			S24-PL1	I	
	S8-PK1	H	S14-PE2	H	
			S14-PF2	L	
			S20-PF2	L	
			S20-PF1	I	
			S24-PL2	I	
	S8-PN1	H	S14-PF1	H	
			S14-PH1	L	
			S20-PH2	L	
			S20-PH1	I	
			S24-PM1	I	
	S8-PS1	H	S14-PH2	H	
			S14-PJ2	L	
			S20-PJ2	L	
			S20-PJ1	I	
			S24-PM2	I	
	S8-PF2	H	S14-PJ1	H	
			S14-PK1	L	
			S20-PK2	L	
			S20-PK1	I	
			S24-PN1	I	
	S8-PK2	H	S14-PK2	H	
			S14-PL2	L	
			S20-PL2	L	
			S20-PL1	I	
			S24-PN2	I	
	S8-PN2	H	S14-PL1	H	
			S14-PM1	L	
			S20-PM2	L	
			S20-PM1	I	
			S24-PP1	I	
	S8-PS2	H	S14-PM2	H	
			S14-PN2	L	
			S20-PN2	L	
			S20-PN1	I	
			S24-PP2	I	
	S8-PV2	H	S14-PN1	H	
			S14-PP1	L	
			S20-PP2	L	
			S20-PP1	I	
			S24-PR1	I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE	DESTINATION
	S9-PC1 H	S15-PC1 H S15-PD2 L S21-PD2 L S21-PD1 I S24-PR2 I	
	S9-PF1 H	S15-PD1 H S15-PE1 L S21-PE2 L S21-PE1 I S24-PS1 I	
	S9-PK1 H	S15-PE2 H S15-PF2 L S21-PF2 L S21-PF1 I S24-PS2 I	
	S9-PN1 H	S15-PF1 H S15-PH1 L S21-PH2 L S21-PH1 I S24-PT2 I	
	S9-PS1 H	S15-PH2 H S15-PJ2 L S21-PJ2 L S21-PJ1 I S24-PU1 I	
	S9-PF2 H	S15-PJ1 H S15-PK1 L S21-PK2 L S21-PK1 I S24-PU2 I	
	S9-PK2 H	S15-PK2 H S15-PL2 L S21-PL2 L S21-PL1 I S24-PV1 I	
	S9-PN2 H	S15-PL1 H S15-PM1 L S21-PM2 L S21-PM1 I S24-PV2 I	
	S9-PS2 H	S15-PM2 H S15-PN2 L S21-PN2 L S21-PN1 I S25-PA1 I	
	S9-PV2 H	S15-PN1 H S15-PP1 L S21-PP2 L S21-PP1 I S25-PB1 I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE		TEST POINTS AND LEVELS FOR TRUE		DESTINATION
	S10-PC1	H	S16-PC1 S16-PD2 S22-PD2 S22-PD1 S25-PC1	H L L I I	
	S10-PF1	H	S16-PD1 S16-PE1 S22-PE2 S22-PE1 S25-PD1	H L L I I	
	S10-PK1	H	S16-PE2 S16-PF2 S22-P F2 S22-PF1 S25-PD2	H L L I I	
	S10-PN1	H	S16-PF1 S16-PH1 S22-PH2 S22-PH1 S25-PE1	H L L I I	
	S10-PS1	H	S16-PH2 S16-PJ2 S22-PJ2 S22-PJ1 S25-PE2	H L L I I	
	S10-PF2	H	S16-PJ1 S16-PK1 S22-PK2 S22-PK1 S25-PF1	H L L I I	
	S10-PK2	H	S16-PK2 S16-PL2 S22-PL2 S22-PL1 S25-PF2	H L L I I	
	S10-PN2	H	S16-PL1 S16-PM1 S22-PM2 S22-PM1 S25-PH1	H L L I I	
	S10-PS2	H	S16-PM2 S16-PN2 S22-PN2 S22-PN1 S25-PH2	H L L I I	
	S10-PV2	H	S16-PN1 S16-PP1 S22-PP2 S22-PP1 S25-PJ1	H L L I I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE		TEST POINTS AND LEVELS FOR TRUE		DESTINATION
	S38-PC1	H	S44-PC1	H	
			S44-PD2	L	
			S50-PD2	L	
			S50-PD1	I	
			S25-PJ2	I	
	S38-PF1	H	S44-PD1	H	
			S44-PE1	L	
			S50-PE2	L	
			S50-PE1	I	
			S25-PK1	I	
	S38-PK1	H	S44-PE2	H	
			S44-PF2	L	
			S50-PF2	L	
			S50-PF1	I	
			S25-PK2	I	
	S38-PN1	H	S44-PF1	H	
			S44-PH1	L	
			S50-PH2	L	
			S50-PH1	I	
			S25-PL1	I	
	S38-PS1	H	S44-PH2	H	
			S44-PJ2	L	
			S50-PJ2	L	
			S50-PJ1	I	
			S25-PL2	I	
	S38-PF2	H	S44-PJ1	H	
			S44-PK1	L	
			S50-PK2	L	
			S50-PK1	I	
			S25-PM1	I	
	S38-PK2	H	S44-PK2	H	
			S44-PL2	L	
			S50-PL2	L	
			S50-PL1	I	
			S25-PM2	I	
	S38-PN2	[illegible]	S4[illegible]-PL1	H	
			S44-PM1	L	
			S50-PM2	L	
			S50-PM1	I	
			S25-PN1	I	
	S38-PN2	H	S44-PM2	H	
			S44-PN2	L	
			S50-PN2	L	
			S50-P[illegible]1	I	
			S25-PN[illegible]	I	
	S38-PV2	H	S44-PN1	H	
			S44-PP1	L	
			S60-PP2	L	
			S50-PP1	I	
			S25-PP1	I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE		TEST POINTS AND LEVELS FOR TRUE		DESTINATION
	S39-PC1	H	S45-PC1 S45-PD2 S51-PD2 S51-PD1 S25-PP2	H L L I I	
	S39-PF1	H	S45-PD1 S45-PE1 S51-PE2 S51-PE1 S25-PR1	H L L I I	
	S39-PK1	H	S45-PE2 S45-PF2 S51-PF2 S51-PF1 S25-PR2	H L L I I	
	S39-PN1	H	S45-PF1 S45-PH1 S51-PH2 S51-PH1 S25-PS1	H L L I I	
	S39 PS1	H	S45 PH2 S45 PJ2 S51 PJ2 S51 PJ1 S25 PS2	H L L I I	
	S39 PF2	H	S45 PJ1 S45 PK1 S51 PK2 S51 PK1 S25 PT2	H L L I I	
	S39 PK2	H	S45 PK2 S45 PL2 S51 PL2 S51 PL1 S25 PU1	H L L I I	
	S39 PN2	H	S45 PL1 S45 PM1 S51 PM2 S51 PM1 S25 PU2	H L L I I	
	S39 PS2	H	S45 PM2 S45 PN2 S51 PN2 S51 PN1 S25 PV1	H L L I I	
	S39 PV2	H	S45 PN1 S45 PP1 S51 PP2 S51 PP1 S25 PV2	H L L I I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE	DESTINATION
	S40-PC1 H	S46-PC1 H S46-PD2 L S52-PD2 L S52-PD1 I S56-PA1 I	
	S40-PF1 H	S46-PD1 H S46-PE1 L S52-PE2 L S52-PE1 I S56-PB1 I	
	S40-PK1 H	S46-PE2 H S46-PF2 L S52-PF2 L S52-PF1 I S56-PC1 I	
	S40-PN1 H	S46-PF1 H S46-PH1 L S52-PH2 L S52-PH1 I S56-PD1 I	
	S40-PS1 H	S46-PH2 H S46-PJ2 L S52-PJ2 L S52-PJ1 I S56-PD2 I	
	S40-PF2 H	S46-PJ1 H S46-PK1 L S52-PK2 L S52-PK1 I S56-PE1 I	
	S40-PK2 H	S46-PK2 H S46-PL2 L S52-PL2 L S52-PL1 I S56-PE2 I	
	S40-PN2 H	S46-PL1 H S46-PM1 L S52-PM2 L S52-PM1 I S56-PF1 I	
	S40-PS2 H	S46-PM2 H S40-PN2 L S52-PN2 L S52-PN1 I S56-PF2 I	
	S40-PV2 H	S46-PN1 H S46-PP1 L S52-PP2 L S52-PP1 I S56-PH1 I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE	DESTINATION
	S41-PC1 H	S47-PC1 H	
		S47-PD2 L	
		S53-PD2 L	
		S53-PD1 I	
		S56-PH2 I	
	S41-PF1 H	S47-PD1 H	
		S47-PE1 L	
		S53-PE2 L	
		S53-PE1 I	
		S56-PJ1 I	
	S41-PK1 H	S47-PE2 H	
		S47-PF2 L	
		S53-PF2 L	
		S53-PF1 I	
		S56-PJ2 I	
	S41-PN1 H	S47-PF1 H	
		S47-PH1 L	
		S53-PH2 L	
		S53-PH1 I	
		S56-PK1 I	
	S41-PS1 H	S47-PH2 H	
		S47-PJ2 L	
		S53-PJ2 L	
		S53-PJ1 I	
		S56-PK2 I	
	S41-PF2 H	S47-PJ1 H	
		S47-PK1 L	
		S53-PK2 L	
		S53-PK1 I	
		S56-PL1 I	
	S41-PK2 H	S47-PK2 H	
		S47-PL2 L	
		S53-PL2 L	
		S53-PL1 I	
		S56-PL2 I	
	S41-PN2 H	S47-PL1 H	
		S47-PM1 L	
		S53-PM2 L	
		S53-PM1 I	
		S56-PM1 I	
	S41-PS2 H	S47-PM2 H	
		S47-PN2 L	
		S53-PN2 L	
		S53-PN1 I	
		S56-PM2 I	
	S41-PV2 H	S47-PN1 H	
		S47-PP1 L	
		S53-PP2 L	
		S53-PP1 I	
		S56-PN1 I	

VDS DIGITAL SIGNAL FLOW

SIGNAL	SOURCE	TEST POINTS AND LEVELS FOR TRUE	DESTINATION
	S42-PC1 H	S48-PC1 H S48-PD2 L S54-PD2 L S54-PD1 I S56-PN2 I	
	S42-PF1 H	S48-PD1 H S48-PE1 L S54-PE2 L S54-PE1 I S56-PP1 I	
	S42-PK1 H	S48-PE2 H S48-PF2 L S54-PF2 L S54-PF1 I S56-PP2 I	
	S42-PN1 H	S48-PF1 H S48-PH1 L S54-PH2 L S54-PH1 I S56-PR1 I	
	S42-PS1 H	S48-PH2 H S48-PJ2 L S54-PJ2 L S54-PJ1(END) I S -P I	
	S42-PF2 H	S48-PJ1 H S48-PK1 L S54-PK2 L S54-PK1(END) I S -P I	
	S42-PK2 H	S48-PK2 H S48-PL2 L S54-PL2 L S54-PL1(END) I S -P I	
	S42-PN2 H	S48-PL1 H S48-PM1 L S54-PM2 L S54-PM1(END) I S -P I	
	S42-PS2 H	S48-PM2 H S48-PN2 L S54-PN2 L S54-PN1(END) I S -P	
	S42-PV2 H	S48-PN1 H S48-PP1 L S54-PP2 L S54-PP1(END) I S -P	

VDS ANALOG SIGNALS

I. SIGNAL DESCRIPTION

A. BAROMETRIC PRESSURE

1. Source -- Supervisor's Console
2. VDS Source -- J19-42
3. Link Drawing Number -- A13-1
4. Destination -- PDP 8/e
5. A/D -- Channel 0, Address 0100
6. Range of Input -- ± 15 VDC, 29.00 to 31.00 inches of mercury
7. Scale of Input -- 61.33 feet / VDC; 920 feet/inch of mercury

B. FIELD ELEVATION

1. Source -- Supervisor's Console
2. Link Drawing Number -- A13-1
3. Destination -- GAT-1, J19-41
4. This signal is not used by the computer program, but is necessary for calibration of other signals.

C. ALTITUDE

1. Source -- Altitude Card (633737E)
2. VDS Source -- J19-$\bar{Y}$
3. Link Drawing Number -- A13-1
4. Destination -- PDP 8/e
5. A/D -- Channel 6, Address 0101
6. Range of Input -- 0 to -15 VDC, 0 to 20,000 feet
7. Scale of Input -- 1333.33 feet/VDC; .00075 VDC/foot

D. AIRSPEED

1. Source -- Relative Wind Card (633743E)
2. VDS Source -- J20-24
3. Link Drawing Number -- A10
4. Destination -- PDP 8/e
5. A/D -- Channel 5, Address 0100
6. Range of Input -- 0 to -10 VDC; 0 to 160 MPH (139 knots)
7. Scale of Input -- 16 MPH/VDC; .0625 VDC/MPH

E. <u>RATE OF CLIMB</u>

1. Source -- Altitude Card (633737E)
2. VDS Source -- J19-T
3. Link Drawing Number -- A13-1
4. Destination -- PDP 8/e
5. A/D -- Channel 7, Address 0110
6. Range of Input -- 0 to ± 10 VDC, 0 to 2500 feet/minute
7. Scale of Input -- 250 feet per minute climb/ - VDC; 250 feet per minute descent/ + VDC

F. <u>SINE OF HEADING ANGLE</u>

1. Source -- ADF Card (633731E), input from motion base system (633002)
2. VDS Source -- J5-H
3. Link Drawing Number -- A31-1
4. Destination -- PDP 8/e
5. A/D -- Channel 3, Address 0100
6. Range of Input -- ± 10 VDC
7. Scale of Input - VDC = 10 sine ... is 0° to 360°

G. <u>COSINE OF HEADING ANGLE</u>

1. Source - ADF Card (633731E), input from motion base system (633002)
2. VDS Source -- J5-K
3. Link Drawing Number -- A31-1
4. Destination -- PDP 8/
5. A/D - Channel 4 Address 0011
6. Range of Input - ± 10 VDC
7. Scale of Input -- VDC = 10 cosine ... is 0 to 360°

H. <u>VOR DEVIATION</u>

1. Source -- VOR/ILS Card (633723E)
2. VDS Source -- J9-H
3. Link Drawing Number -- A32-1
4. Destination -- PDP 8/e
5. A/D -- Channel 8, Address 0111
6. Range of Input -- ± 10 VDC
7. Scale of Input + VDC indicates fly right, - VDC indicates fly left. There is no scale in degrees or distance indicated in GAT-1 literature. From GAT-1 operations, it appears to be approximately 10°/VDC.

I. SINE OF PITCH ANGLE

1. Source -- Attitude Card (633745E); input from motion base system (633002)
2. VDS Source -- J22-21
3. Link Drawing Number -- A15
4. Destination -- PDP 8/e
5. A/D -- Channel 2, Address 0001
6. Range of Input -- + 9.64 to - 5.13 VDC
7. Scale of Input -- VDC = 15 sine 2 Θ, Θ is +20° to - 10°; + VDC for nose-up, -VDC for nose-down.
8. This analog input is not presently used in the VDS system.

J. SINE OF ROLL ANGLE

1. Source -- Attitude Card (633745E), input from motion base system (633002)
2. VDS Source -- J22-30
3. Link Drawing Number -- A16
4. Destination -- PDP 8/e
5. A/D -- Channel 1, Address 0000
6. Range of Input -- ± 14.5 VDC
7. Scale of Input -- VDC = 15 sine 6 . . . is - 12.5° to + 12.5°, + VDC for right bank, - VDC for left bank
8. This analog input is not presently used in the VDS system.

K. WIND VELOCITY

1. Source -- Supervisor's Console
2. Link Drawing Number -- A22-1
3. Destination -- GAT-1, J6-39
4. Range of Output (J6-S) -- 0 to + 10 VDC, 0 to 100 knots
5. Scale of Output (J6-S) -- 10 knots/VDC
6. Although this signal is not used in the VDS program, it is important for varying task loading. To ensure that task loading is constant, it is necessary to calibrate this signal and periodically check the voltage outputs

L. WIND DIRECTION (SINE HEADING)

1. Source -- Supervisor's Console
2. Link Drawing Number -- A22-1
3. Destination -- GAT-1, J6-15
4. Range of Input -- ± 10 VDC
5. Scale of Input -- VDC = 10 sine . . . = 0° to 360°
6. Same as 6 above

M. WIND DIRECTION (COSINE HEADING)

1. Source -- Supervisor's Console
2. Link Drawing Number -- A22-1
3. Destination -- GAT-1, J6-41
4. Range of Input ± 10 VDC
5. Scale of Input -- VDC = 10 cosine . . . = 0 to 360°
6. Same as 6 above

II. CALIBRATION PROCEDURES

A. BAROMETRIC PRESSURE

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN
c. Engine SHUT DOWN

Step 1. Connect a DVM (Digital Voltmeter) to output signal BNC connector labeled BARO located on the GAT-1 Outputs Connector Panel at the back of the Supervisor's Console.

Step 2. Adjust BARO potentiometer located on the front of the Supervisor's Console until the DVM reads 0 volts.

Step 3. Connect DVM to BNC connector labled ALT and adjust potentiometer labeled FIELD ELEVATION to 0 volts. Lock in this setting.

Step 4. Check to see that the altimeter in the GAT-1 is reading zero feet at a barometric pressure setting of 30.00. If a zero altimeter reading is not obtained, reset the altimeter. For this adjustment, loosen the baro set screw located at the lower lefthand side, push the set screw aside, and then pull out the baro knob and set. Both field elevation and barometric DVM readings should be 0 volts.

Step 5. At this point, initial conditions for calibration are established. Record the BARO and ALT voltage, and the baro adjust pot on the Supervisor's Console.

Step 6. Increment present value of mechanical barometric pressure on altimeter by a value of .04. Use the knob at the base of the left hand side of the altimeter.

Step 7. Adjust potentiometer BARO to obtain an altimeter reading of zero feet. Record the voltage readings from BNC connectors, BARO and ALT, and the baro potentiometer dial setting.

Step 8. Repeat steps 6 and 7 until the top full range (31.00) of the mechanical barometric pressure on altimeter is covered.

Step 9. Repeat steps 6 and 7 for .04 decreasing values from initial conditions until the bottom full range (29.00) is covered.

B. FIELD ELEVATION

Calibration of this analog signal is to be done under the following conditions:

a. GAT-1 Electrical Power On
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN
c. GAT-1 Engine SHUT DOWN

Step 1. Connect a DVM (Digital Voltmeter) to output signal BNC connector labeled BARO located on the GAT-1 Output Connector Panel at the back of the Supervisor's Console.

Step 2. Adjust the BARO potentiometer on the front of the Supervisor's Console for a DVM reading of 0 volts.

Step 3. Connect a DVM to output signal BNC connector labeled ALT.

Step 4. Adjust the FIELD ELEVATION potentiometer until a reading of 0 volts is obtained.

Step 5. Set the mechanical barometric pressure on altimeter to a value of 30.00. If the altimeter reading is not zero feet, reset the altimeter (see Step 4 of the barometric pressure calibration).

Step 6. Adjust the FIELD ELEVATION potentiometer to obtain altimeter readings ranging from 0 to 3000 feet in 100 feet increments. Record the dial setting of the FIELD ELEVATION potentiometer and voltage readings for the various altimeter indications.

C. ALTITUDE

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN
c. Engine SHUT DOWN

Step 1. Connect a DVM (Digital Voltmeter) to output signal BNC connector labeled ALT located on the GAT-1 Output Connector Panel at the back of the Supervisor's Console.

Step 2. Set the mechanical barometric pressure on altimeter to 30.00 and the altitude to zero feet. The DVM readings for BARO and ALT should be zero. If not, do Steps 2, 3, and 4 of the barometric pressure calibration.

Step 3. Set the altimeter for altitudes ranging 0 to 10,000 feet in increments of 100 feet. Record the DVM reading and the altimeter setting. (The altimeter can be manually controlled by the pushbutton switches on the outside edge of the altitude card in the GAT. This card is in the slot J19 and is the seventh card from the right on the top rack in the tail section. The blue and green buttons, respectfully, increase and decrease the altimeter readings. To freeze the altimeter setting, place the toggle switch above the push buttons in the downward position.)

Step 4. When the calibration is complete, reset the altimeter to ground level using the manual controls referred to in Step 3. The light bulb on the altitude card will come on and a tire screech will be heard when the GAT-1 reaches the ground. The DVM reading for ALT should be 0 VDC. If 0 VDC is not obtained, repeat Steps 2, 3, and 4.

D. AIRSPEED

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN
c. Engine SHUT DOWN

Step 1. Connect a DVM (Digital Voltmeter) to output signal BNC connector labeled IAS located on the GAT-1 Output Connector Panel at the back of the Supervisor's Console.

Step 2. Change the mechanical airspeed indicator for speeds ranging from 40 MPH to 160 MPH in increments of 5 MPH using the manual controls. Record the DVM reading and the airspeed indicator reading. [The relative wind card has a switch which enables manual control of the airspeed by a 10-turn potentiometer. For manual control, the switch must be placed in a downward position, and the pot adjusted (clockwise) until airspeed indicator has the desired reading. Both the switch and the potentiometer are located on the outside edge of the card. This card fits in slot J20 and is the sixth card from the right on the top rack in the tail section.]

Step 3. When the calibration is complete, reset airspeed to 0 VDC and place the switch to the upward position.

E. RATE OF CLIMB

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo Systems for Roll and Yaw SHUT DOWN
c. Servo System for Pitch ENERGIZED
d. Engine ON

Step 1. Connect a DVM (Digital Voltmeter) to output signal BNC connector labeled R/C located on the GAT-1 Output Connector Panel at the back of the Supervisor's Console.

Step 2. Push in throttle and air mixture controls fully. Release parking brake (push in the control) and let airspeed build up to at least 80 MPH.

Step 3. Pull back on the yoke for a climb attitude of approximately 500 feet/minute as read by the Vertical Speed Indicator. Shut down the pitch servo system.

Step 4. Increment the Vertical Speed Indicator to 100 feet/minute climb rates using the trim tab located on the lower right side of the cockpit. Record the indicator reading and the DVM voltage. (Different pitch attitudes may be required to obtain measures from 0 to 1000 feet/minute. To change pitch attitude: put the trim tab to its neutral position, energize the pitch servo system, and change attitude to desired level.)

Step 5. Repeat Steps 2 and 3 for the descent attitude of the GAT-1.

Step 6. Bring the GAT-1 to ground level either by descent pitch attitude (servo system ON) or by use of the manual controls on the altitude card. Put the trim tab to neutral position.

F. HEADING

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo System for Pitch and Roll SHUT DOWN
c. Servo System for Yaw ENERGIZED
d. Engine SHUT DOWN

Step 1. Connect a DVM (Digital Voltmeter) to output signal BNC connector labeled HDG sin located on the GAT-1 Output Connector Panel at the back of the Supervisor's Console.

Step 2. Set the airspeed indicator to 100 MPH using the manual controls on the relative wind card. See Part D, Step 2. [Airspeed is necessary for rudder control of the Yaw motion system.]

Step 3. Set the Directional Gyro Indicator to a particular heading (i.e., North) using the rudder pedals. When the heading indication is reached, shut down the Yaw servo system.

Step 4. Record the indicator reading and the DVM output.

Step 5. Change the BNC connector to HDG COS and record this voltage reading.

Step 6. Increment the heading 5° for the full 360° scale and repeat Steps 2, 3, 4, and 5.

Step 7. Set airspeed indicator to zero and place the switch to an upward position.

G. VOR DEVIATION

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo Systems for Pitch, Roll, and Yaw SHUT DOWN
c. Engine SHUT DOWN
d. MARK 12A Panel ON (upper knob on left half of panel)

Step 1. Connect a DVM (Digital Voltmeter) to output signal BNC connector labeled VOR DEV located on the GAT-1 Output Connector Panel at the back of the Supervisor's Console.

Step 2. Slew the GAT-1 due south of a VOR station (180° radial) using the slew switches on the X-Y plotter.

Step 3. Set the OMNI bearing (outer dial) selector to 0° using the knob at the base of the VOR instrument. The VOR course indicator should read TO station and the course deviation indicator needle should be in a vertical position with 180° at the top and 0° at the bottom. If not, do not continue with the calibration procedures until this setting is achieved. Check to see that the station location is programmed properly (see Section IX, Navigational Area Programming Panels).

Step 4. Record the mechanical setting of the OMNI bearing selector and the DVM reading.

Step 5. Repeat Step 4 for the full 360° range using 10° radial increment of the OMNI bearing selector. The VOR course indicator should read TO for approximately a 180° arc and FROM for a 180° arc. For example, when located due south of a VOR station, the course indicator should read TO anywhere from 90° - 0° - 270°. A FROM reading should be obtained from 90° - 180° - 270°. At 90° and 270° the TO/FROM flag should read OFF.

H. WIND VELOCITY

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN
c. Engine SHUT DOWN

Step 1. Connect a DVM (Digital Voltmeter) to J6-S in the tail section of the GAT-1.
Step 2. Set the wind velocity control, located on the Supervisor's Console, to the OFF position (fully clockwise).
Step 3. Record the DVM reading and the knob position.
Step 4. Turn the knob counter-clockwise 180°. Record the DVM reading.
Step 5. Continue making 180° turns and record the readings until 10 full complete turns have been made. Ideally, each full turn should be equivalent to 1 VDC.
Step 6. After the calibrations are complete, return the control to zero, or leave the knob at its highest setting and calibrate wind direction.

I. WIND DIRECTION

Calibration of this analog signal is to be performed under the following conditions:

a. GAT-1 Electrical Power ON
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN
c. Engine SHUT DOWN

Step 1. Connect a DVM (Digital Voltmeter) to J6-S and set the wind direction pot to the full ON position, and record the voltage reading. This reading should be approximately 10 VDC.
Step 2. Connect the DVM to J6-15 (sine heading).
Step 3. Set the wind direction pot located on the Supervisor's Console to 0°.
Step 4. Record the DVM reading from J6-15 and the pot indication.
Step 5. Connect the DVM to J6-41 (cosine heading) and record this reading.
Step 6. Repeat Steps 3, 4, and 5 in 30° increments for the full 360° range.
Step 7. After the calibrations are complete, set the wind control knob to zero.

III. CALIBRATION

Tables 6-I through 6-IX give the actual measurements obtained in the initial calibration of the analog signals used in the VDS system. Figures 6-1 through 6-9 illustrate the functional relationship of each signal.

Table 6-I

BAROMETRIC PRESSURE CALIBRATION

Field Elevation Pot Setting: 524

ON BOARD BARO	ANALOG BARO	ANALOG ALT	INSTRUCTOR'S BARO POT
29.00	Exceeds Limitation of Potentiometer		
29.04	-14.57	-.665	107
29.08	-13.78	-.630	129
29.12	-13.18	-.602	149
29.16	-12.51	-.570	172
29.20	-11.864	-.541	194
29.24	-11.280	-.514	214
29.28	-10.697	-.486	234
29.32	-10.077	-.458	255
29.36	- 9.514	-.432	274
29.40	- 8.932	-.406	294
29.44	- 8.353	-.378	313
29.48	7.796	-.353	333
29.52	- 7.192	-.324	353
29.56	- 6.630	-.299	372
29.60	- 6.058	-.272	392
29.64	- 5.472	-.245	412
29.68	- 4.855	-.216	433
29.72	- 4.245	-.187	453
29.76	- 3.618	-.158	475
29.80	- 3.082	-.133	494
29.84	- 2.461	-.104	515
29.88	- 1.900	-.078	[illegible]
29.92	- 1.324	-.052	553
29.96	- .707	-.023	575
30.00	.000	.008	599
30.04	.557	.033	617
30.08	1.065	.058	636
30.12	1.589	.082	653
30.16	2.313	.108	678
30.20	2.851	.133	697
30.24	3.369	.158	715
30.28	3.872	.183	732
30.32	4.428	.210	751
30.36	4.990	.236	770
30.40	5.553	.263	789
30.44	6.084	.288	808
30.48	6.697	.316	828
30.52	7.264	.343	848
30.56	7.773	.367	865
30.60	8.327	.393	885
30.64	8.892	.419	904
30.68	9.514	.448	925
30.72	10.016	.471	942
30.76	10.598	.498	962
30.80	11.238	.528	984
30.84	11.853	.557	1005
30.88	12.45	.585	1026
30.92	13.00	.611	1044
30.96	13.54	.635	1062
31.00	14.18	.665	1083

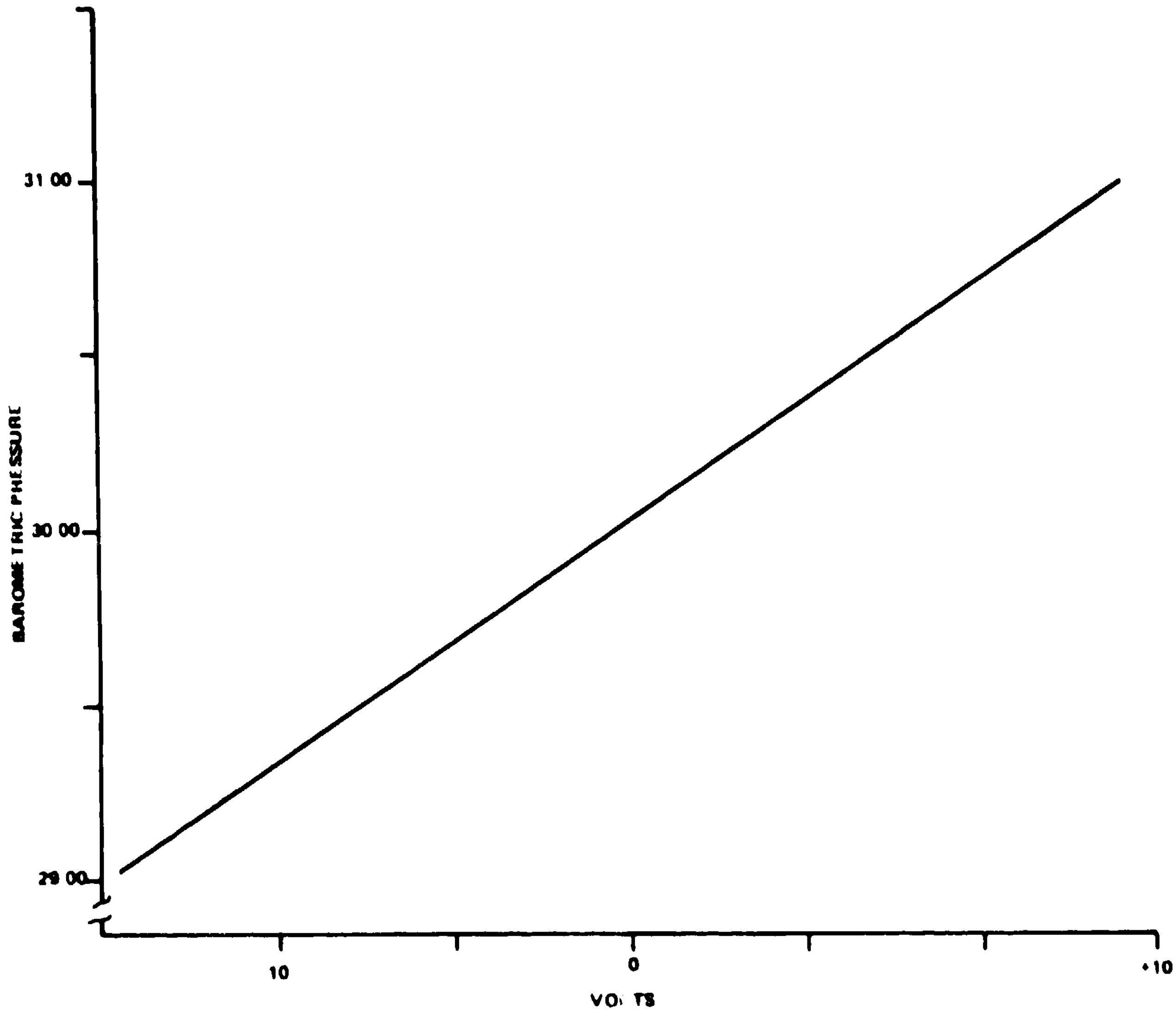


Figure 6-1. Functional Relationship of Analog Readings to Barometric Pressure Indications.

Table 6 II

FIELD ELEVATION

Altimeter	Analog Altitude	Pot Setting
-1000	.729	148
900	.653	165
800	.579	183
700	.506	203
600	.435	224
500	.356	251
400	.280	279
300	.206	309
200	.137	341
100	.064	376
0	.001	412
100	.079	456
200	.149	496
300	.221	536
400	.297	577
500	.373	617
600	.449	654
700	.521	687
800	.597	719
900	.683	747
1000	.760	773
1100	.836	796
1200	.912	817
1300	.982	834
1400	1.061	857
1500	1.138	868
1600	1.210	881
1700	1.281	893
1800	1.357	906
1900	1.427	914
2000	1.490	923
2100	1.570	932
2200	1.640	940
2300	1.714	948
2400	1.795	955
2500	1.869	962
2600	1.942	968
2700	2.016	974
2800	2.089	979
2900	2.169	985
3000	2.248	990

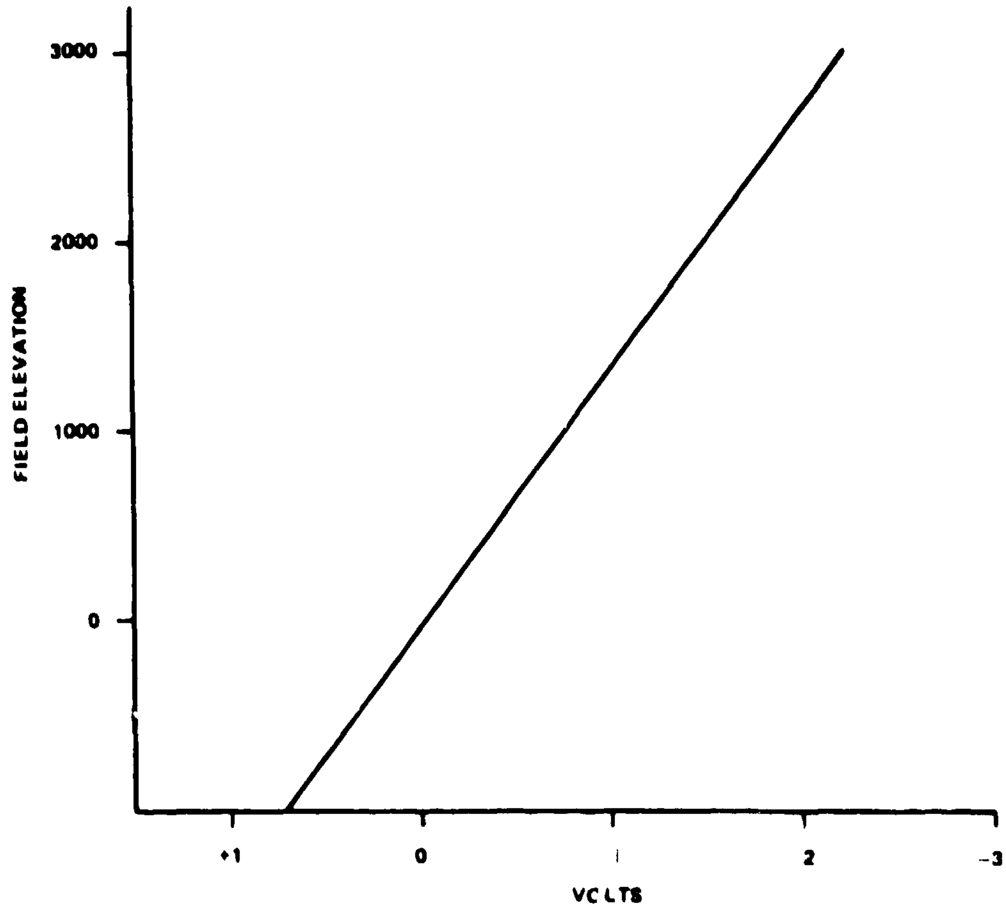


Figure 6-2. Functional Relationship of Analog Readings to Altimeter Indications with the Field Elevation Pot

Table 6-III

ALTITUDE CALIBRATION

Altimeter	Analog Altitude
0	+ .019
100	– .054
200	- .126
300	- .202
400	- .278
500	– .356
600	- .425
700	.499
800	- .578
900	- .660
1000	- .730
1500	-1.109
2000	-1.471
2500	1.841
3000	2.217
3500	2.594
4000	-2.960
4500	-3.329
5000	-3.705
5500	4.085
6000	4.449
6500	4.818
7000	-5.188
7500	-5.564
8000	5.931
8500	-6.308
9000	6.673
9500	7.059
10000	-7.420

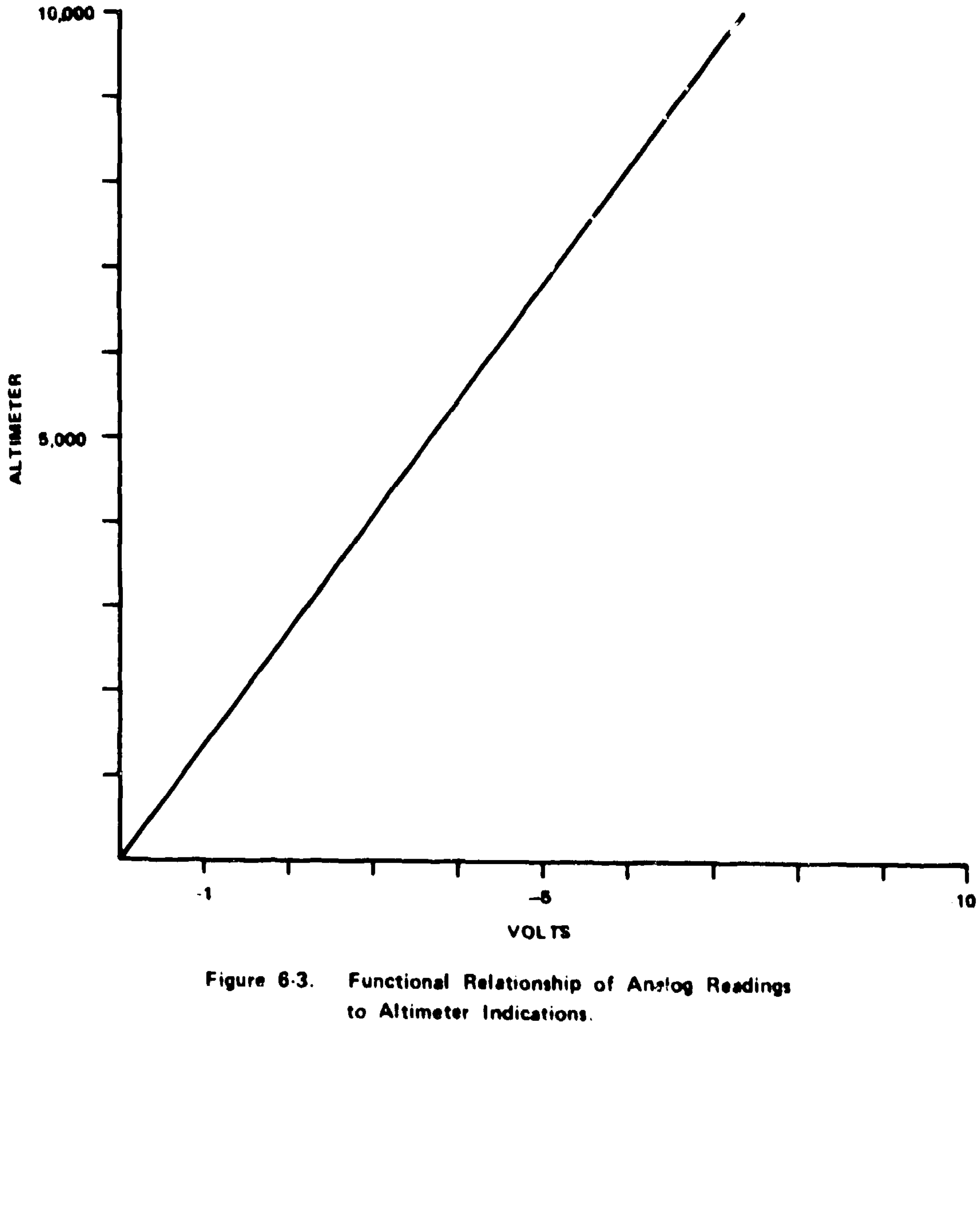


Figure 6-3. Functional Relationship of Analog Readings to Altimeter Indications.

Table 6-IV

AIRSPEED CALIBRATION

Airspeed Indicator (MPH)	Analog IAS
40	-2.178
45	-2.576
50	-2.919
55	-3.255
60	-3.601
65	3.891
70	-4.167
75	-4.487
80	-4.755
85	-5.097
90	-5.389
95	-5.749
100	-6.068
105	-6.413
110	-6.722
115	-7.006
120	-7.432
125	-7.775
130	-8.130
135	-8.451
140	-8.781
145	-9.062
150	-9.314
155	-9.596
158	-10.286

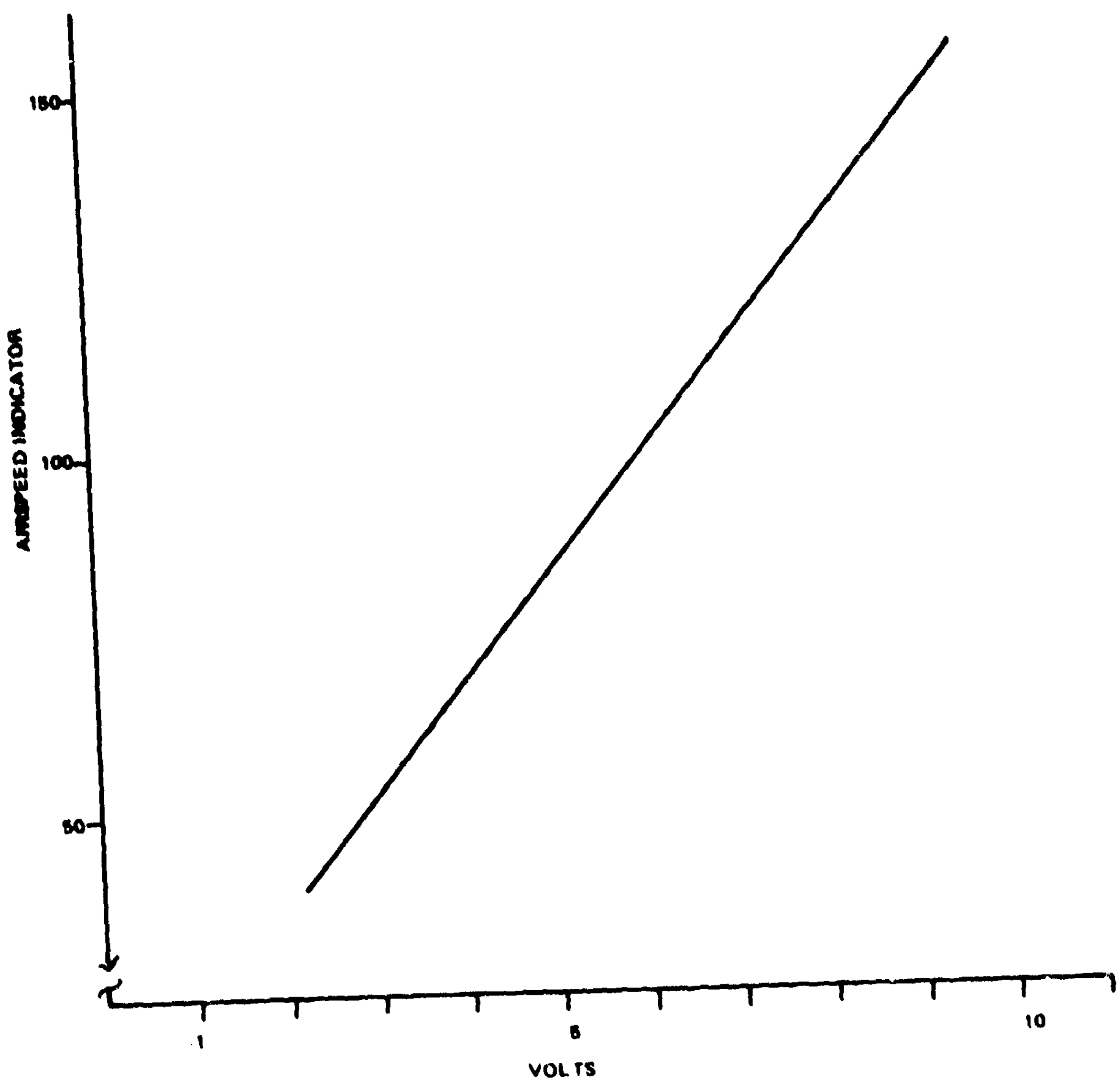


Figure 6-4. Functional Relationship of Analog Readings to Airspeed Indications.

Table 6-V

RATE OF CLIMB CALIBRATION

Vertical Speed Indicator	Ascending Analog R/C	Decending Analog R/C
0	+0.021	-0.027
100	-0.335	+0.326
200	-0.[illegible]84	+0.664
300	-1.025	+1.045
400	-1.374	+1.390
500	-1.735	+1.719
600	-2.035	+2.072
700	-2.328	+2.477
800	-2.760	+2.815
900	-3.102	+3.186
1000	-3.447	+3.480

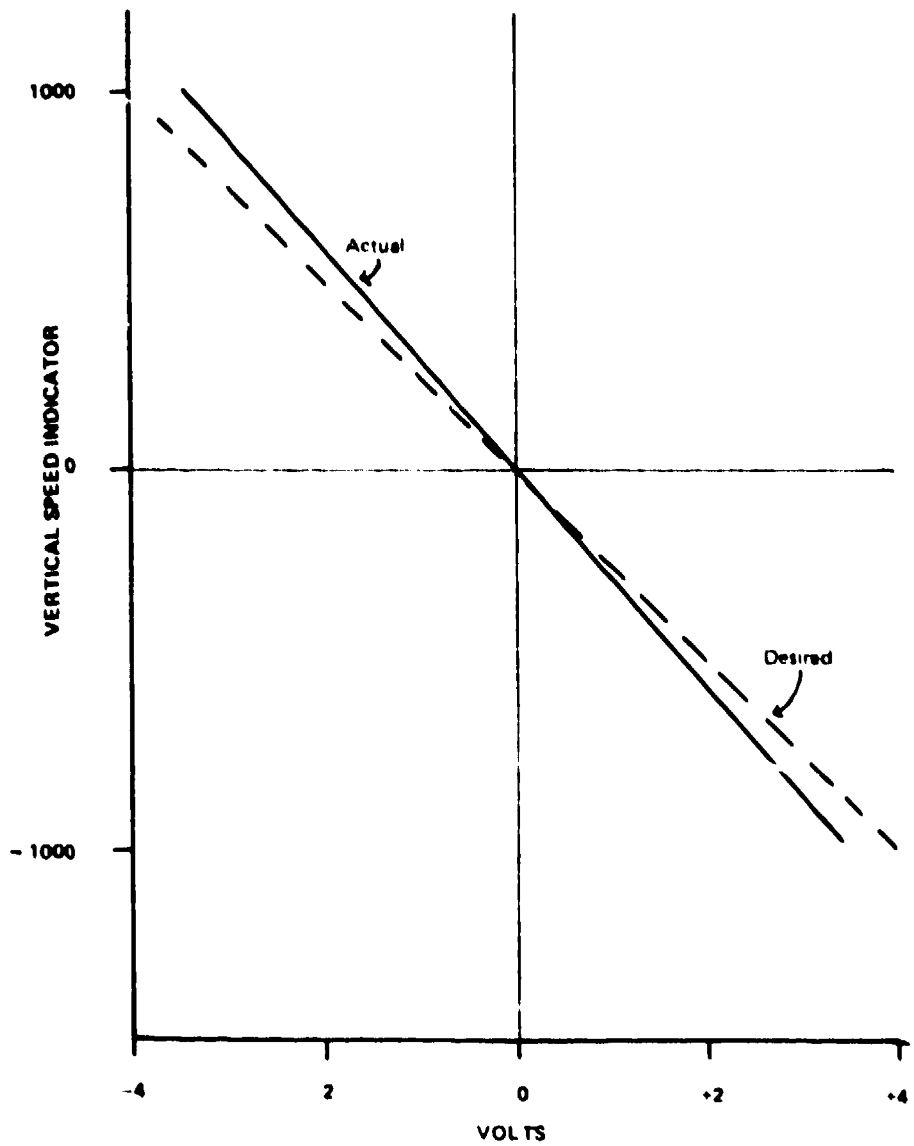


Figure 6-5. Functional Relationship of Analog Readings to Vertical Speed Indications.

Table 6-VI

HEADING CALIBRATION

DIRECTIONAL GYRO INDICATOR	ANALOG SIN	ANALOG COS
0°	+ 0.195	– 9.919
10°	– 1.633	– 9.629
20°	– 3.361	– 9.141
30°	– 4.949	– 8.406
40°	– 6.276	– 7.444
50°	– 7.575	– 6.168
60°	– 8.512	– 4.921
70°	– 9.307	– 3.311
80°	– 9.753	– 1.782
90°	– 9.918	– 0.010
100°	– 9.702	+ 1.597
110°	– 9.152	+ 3.192
120°	– 8.462	+ 4.540
130°	– 7.382	+ 6.051
140°	– 6.116	+ 7.347
150°	– 4.777	+ 8.433
160°	– 3.423	+ 9.205
170°	– 1.801	+ 9.786
180°	– 0.137	+10.008
190°	+ 1.555	+ 9.841
200°	+ 3.162	+ 9.326
210°	+ 4.727	+ 8.529
220°	+ 6.189	+ 7.497
230°	+ 7.450	+ 6.250
240°	+ 8.459	+ 4.906
250°	+ 9.264	+ 3.451
260°	+ 9.831	+ 1.724
270°	+10.028	+ 0.017
280°	+ 9.847	– 1.635
290°	+ 9.294	– 3.191
300°	+ 8.543	– 4.625
310°	+ 7.457	6.107
320°	+ 6.127	– 7.417
330°	+ 4.667	– 8.478
340°	+ 3.166	– 9.216
350°	+ 1.632	– 9.642
360°	+ 0.195	– 9.919

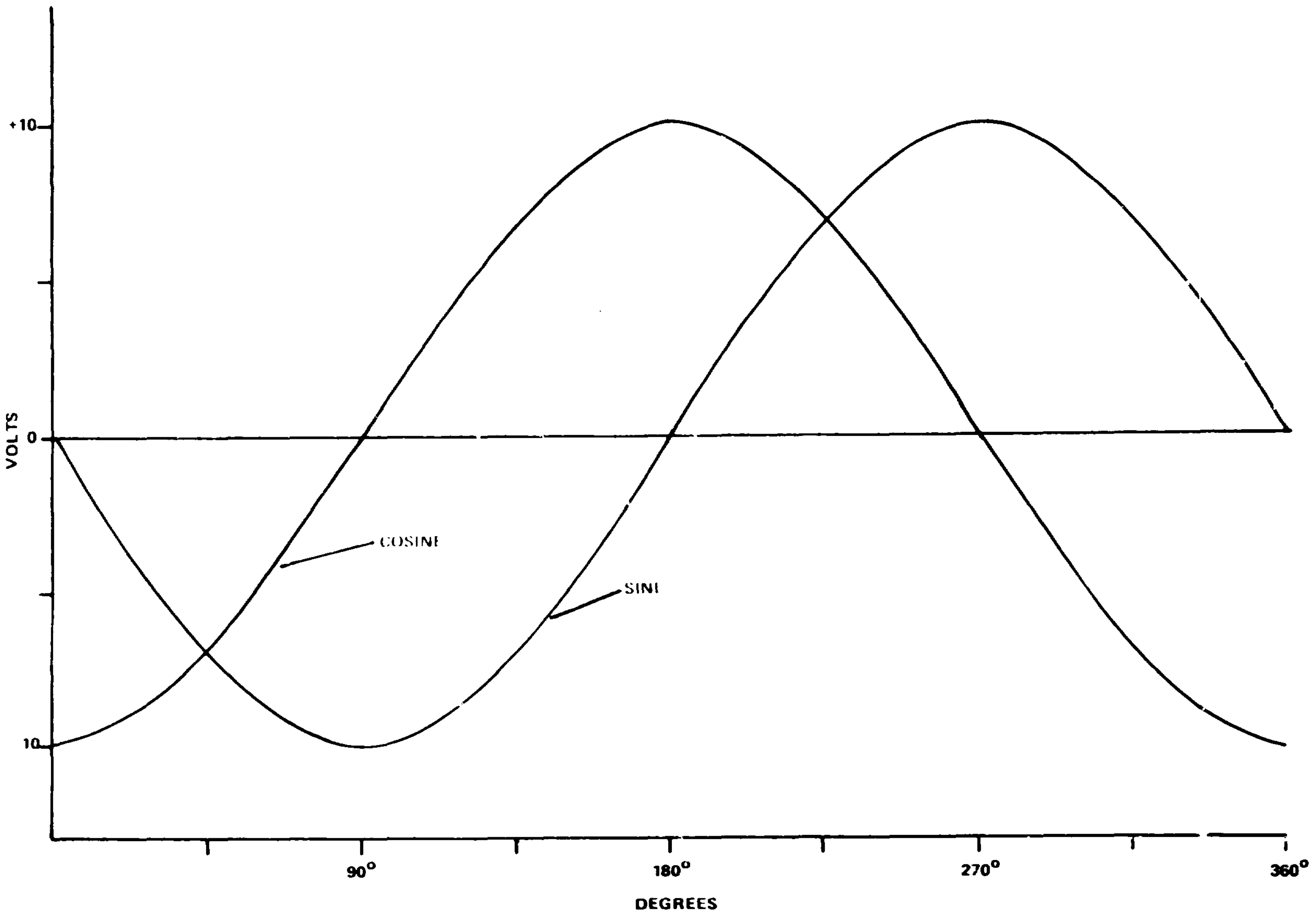


Figure 6-6. Functional Relationship of Analog Readings to Heading Indications.

Table 6-VII

VOR DEVIATION CALIBRATION

OMNI Bearing Selector	Analog VOR DEV
0	.020
10	- 1.480
20	2.580
30	3.440
40	4.230
50	4.950
60	5.680
70	6.540
80	7.550
90	- 8.800
100	7.460
110	6.400
120	5.600
130	4.760
140	4.030
150	3.220
160	2.350
170	1.270
180	+ 0.440
190	+ 1.870
200	+ 3.020
210	+ 4.050
220	+ 4.950
230	+ 5.750
240	+ 6.800
250	+ 7.610
260	+ 8.870
270	+10.47
280	+ 8.82
290	+ 7.590
300	+ 6.560
310	+ 5.610
320	+ 4.730
330	+ 3.860
340	+ 2.910
350	+ 1.720

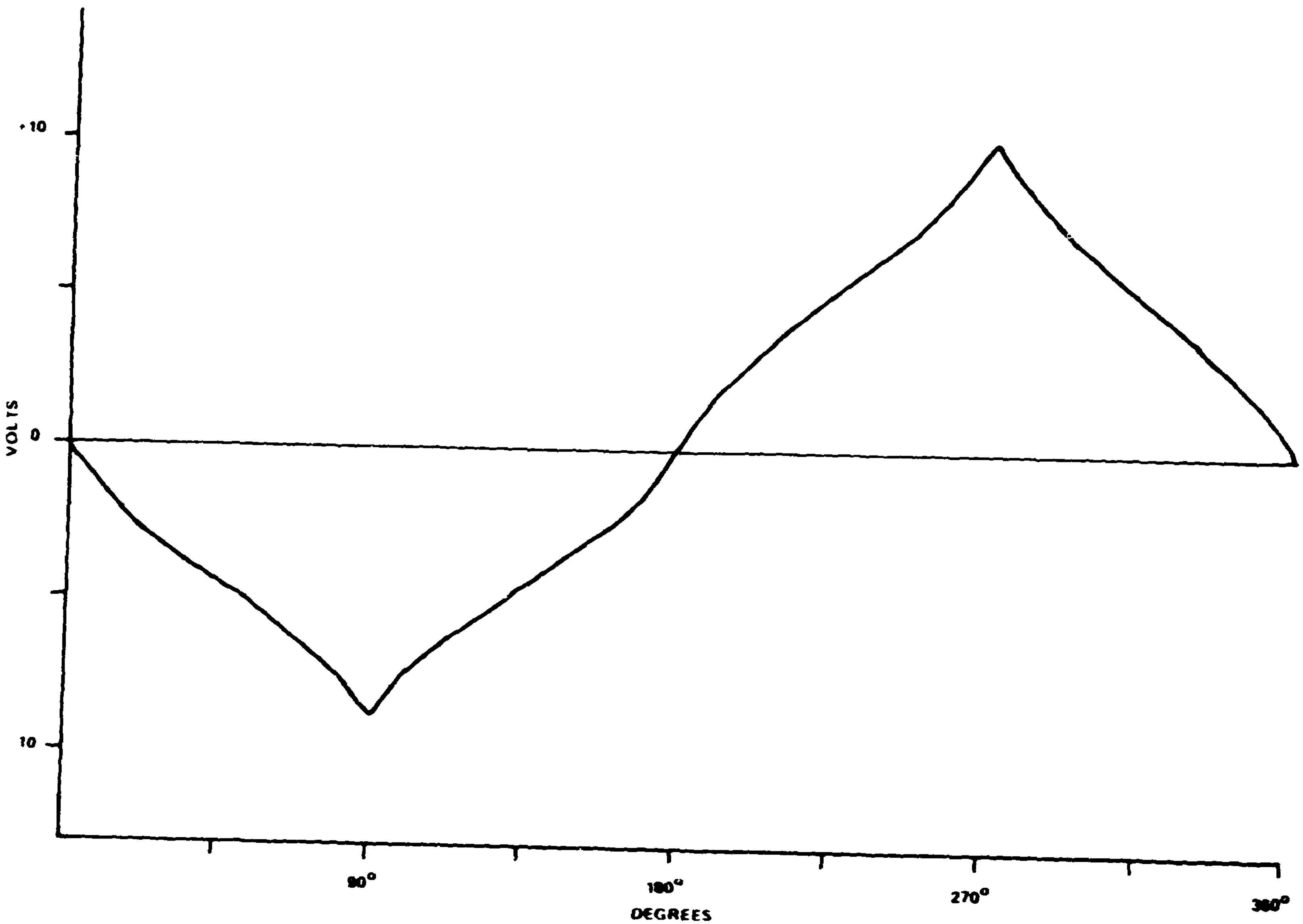


Figure 6-7. Functional Relationship of Analog Readings to OMNI Selector Indications.

Table 6-VIII

WIND VELOCITY CALIBRATION

Pot Turns	Voltage
0	.055
.5	.527
1.0	1.001
1.5	1.481
2.0	1.953
2.5	2.429
3.0	2.901
3.5	3.379
4.0	3.851
4.5	4.332
5.0	4.809
5.5	5.289
6.0	5.769
6.5	6.256
7.0	6.738
7.5	7.227
8.0	7.722
8.5	8.223
9.0	8.725
9.5	9.236
10.0	9.755

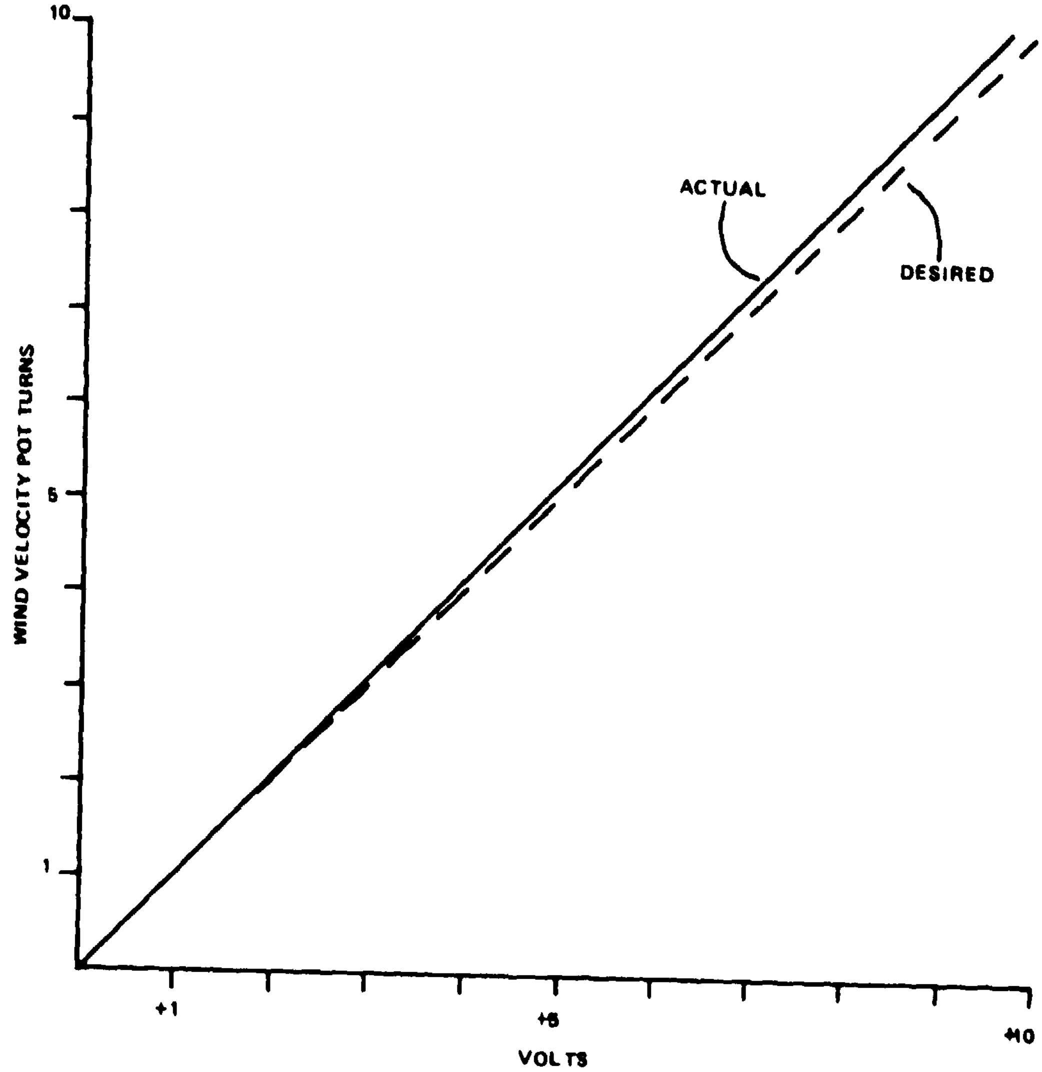


Figure 6-8. Functional Relationship of Analog Readings to Wind Velocity Pot Turns

Table 6-IX

WIND DIRECTION CALIBRATION

Wind Velocity = 10.0 = 9.765v

Pot Setting	Sine Voltage	Cosine Voltage
0^{o}	+0.063	+9.739
30^{o}	+5.083	+8.195
60^{o}	+8.673	+4.201
90^{o}	+9.664	-0.232
120^{o}	+8.320	-4.927
150^{o}	+4.537	8.581
180^{o}	+0.061	-9.738
210^{o}	-4.643	-8.370
240^{o}	-8.184	-4.967
270^{o}	-9.756	0.260
300^{o}	-8.530	+4.687
330^{o}	-5.161	+8.222
360^{o}	+0.063	+9.739

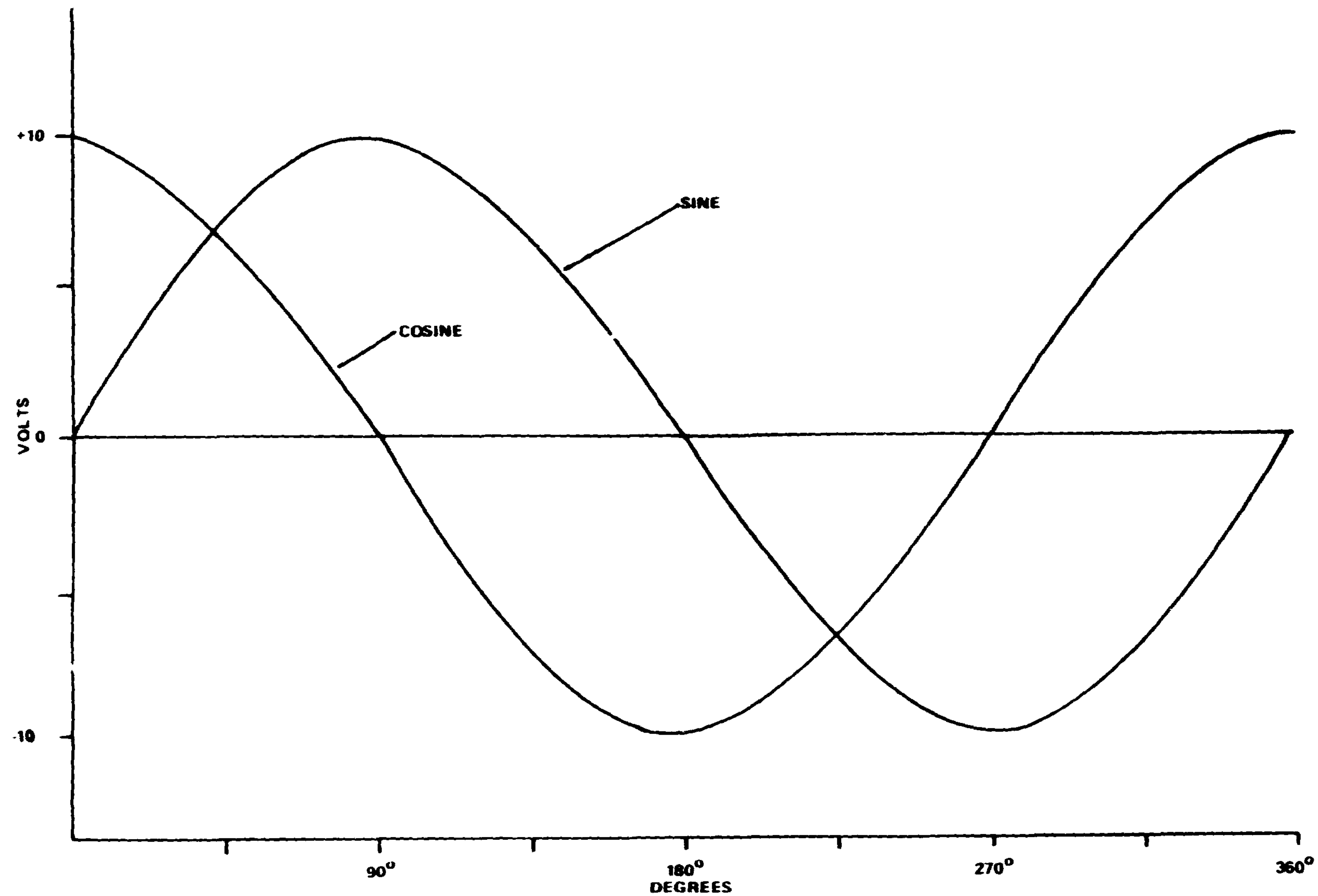


Figure 6 9. Functional Relationship of Analog Readings to Wind Direction Heading Indications.

IV. CALIBRATION OF PDP 8/e ANALOG CONVERTER

The A/D calibration test is done with a software program which collects 100 A/D sample measurements and calculates an arithmetic average of the samples. A voltage reference electronic circuit built by Electronics Service Division is used for input to the A/D, and the software program offers provision for changing the gain of the Analog Voltage Calibrator unit. Figure 6-10 shows a block diagram of the test set up.

A. PROCEDURES

Step 1. Load the program (Follow Steps 1, 2, 3, and 4 of Appendix D, Part II. For Step 4, set switches 6-11 to 30_8 instead of 33_8 and substitute the Floating Point Program -23 bit for the Linking Loader. Repeat Step 4, as above, but use the Binary A/D Calibration Program.)

Step 2. Install eight BNC cable from the Analog Voltage Calibrator to eight BNC connectors inside the PDP 8/e mini computer. (Channels 1 and 2 are not presently used in the VDS system.)

Step 3. Plug the Analog Voltage Calibrator into an AC receptacle.

Step 4. Turn power switch ON and let unit warm up for about fifteen minutes.

Step 5. Start the program. Set SR to 30_8; press EXTD ADDR LOAD. Set SR to 200_8, press ADDR LOAD. Press CLEAR and CONT.

Step 6. The program will print out the following heading: GAIN VIN CH1 CH2 CH3 CH4 CH5 CH6 CH7 CH8.

Step 7. Select the value of Vin desired on the Analog Voltage Calibrator by the control knob on the unit and set the polarity switch. Initially set the control to zero and polarity switch to plus. (There are six values ranging from 0 to 5 which can be selected. These values represent the input voltages to the A/D.)

Step 8. Select from the following chart which gain value is desired. Initially select a gain of 1. (With a gain greater than 1, testing can be done for voltages over 5 VDC.)

Gain	Character Input
1	0000
2	0064
4	0128
8	0214

Step 9. Enter the four digit characters corresponding to the appropriate gain on the TTY. After entering the four digits, depress the space bar.

Step 10. Enter the values of input voltage and its polarity provided by the Analog Voltage Calibrator. (This value must be a four digit number; therefore, a value of zero is entered in as 0000, 1 as 0001, 2 as 0002, etc.. To designate polarity, a plus sign must precede the four digit number for positive voltages while a minus sign is used for negative voltages.) After entering the sign value and the four digit number, depress the space bar.

Step 11. A printout of the arithmetic average of 100 samples for each channel will be obtained. The end of a computer run is designated on the printout by a +0.

Step 12. Results should be compared to Table 10. PDP 8/e Analog Calibration Decimal Readout.

Step 13. Repeat Steps 5 thru 12 for each unit voltage values between ±10 VDC

Step 14. After testing is complete, press HLT on the computer console.

Step 15. Place power switch on the Analog Voltage Calibrator Unit to OFF.

Step 16. Remove interconnecting cables between Analog Voltage Calibrator Unit and analog inputs to the PDP 8/e.

Step 17. Reconnect the PDP 8/e analog cables to their appropriate BNC connector.

Step 18. Reload VDS program.

B. CALIBRATION

Tables 6-X and 6-XI give the actual measurements in decimal and octal code of the A/D calibration for each of the A/D channels. Figure 6-11 depicts the functional relationship for the signals.

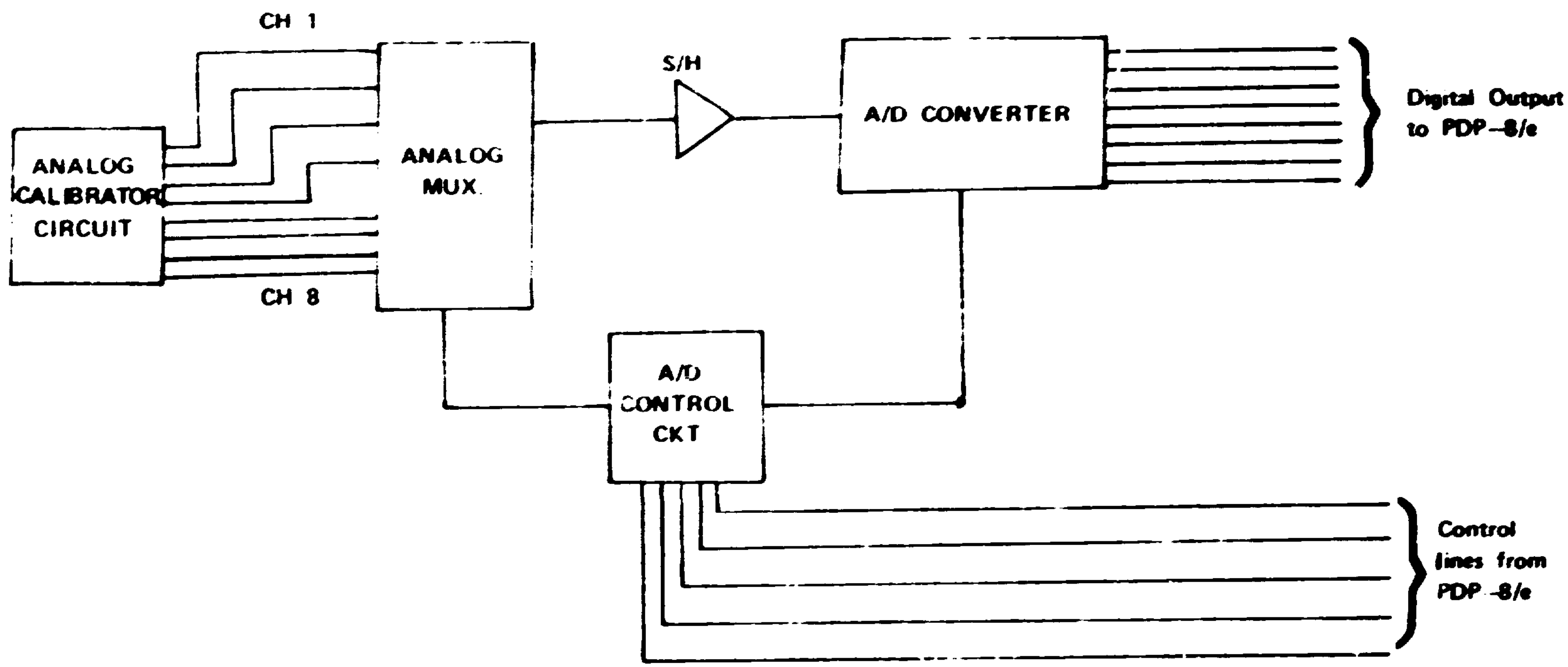


Figure 6-10 Block Diagram of Test Setup.

Table 6-X

PDP 8/e ANALOG CALIBRATION DECIMAL READOUT

Vin Volts	Roll Sin CH1/00	Pitch Sin CH2/01	Heading Sin CH3/02	Heading Cosine CH4/03	IAS CH5/04	Altitude CH6/05	R/C CH7/06	VOR CH8/07	BARO CH8/10
10	682								682
9	614	921	921	921	921	921	921	921	614
8	546	819	819	819	819	819	819	819	546
7	477	716	716	716	716	716	716	716	477
6	408	614	614	614	614	614	614	614	614
5	341	512	512	512	512	512	512	512	341
4	272	409	409	409	409	409	409	409	272
3	204	307	307	307	307	307	307	307	204
2	136	205	205	205	205	205	205	205	136
1	68	102	102	102	102	102	102	102	68
0	0	0	0	0	0	0	0	0	0
-1	-68	-103	103	103	103	103	-103	-103	-68
-2	137	205	205	-205	205	-205	-205	-205	-137
3	-205	-307	307	307	307	307	-307	-307	-137
4	273	-410	410	410	410	410	-410	-410	-273
-5	341	512	512	512	512	-512	-512	-512	-341
-6	410	-614	614	614	614	614	614	-614	-410
7	478	717	717	717	717	717	717	-717	-478
8	546	819	819	819	819	819	-819	-819	-546
9	614	-921	-921	921	921	-921	-921	-921	-614
-10	-682								-682
+FSC 1777	14.995	9.9920	9.9920	9.991	9.991	9.9920	9.9910	9.990	14.990
-FSC 6000	15.004	-9.990	9.987	9.997	-9.997	-9.997	-9.998	-9.997	-14.999

Table 6 XI

PDP 8/e ANALOG CALIBRATION OCTAL READOUT

Vin Volts	Roll Sin CH1/00	Pitch Sin CH2/01	Heading Sin CH3/02	Heading Cosine CH4/03	IAS CH5/04	Altitude CH6/05	R/C CH7/06	VOR CH8/07	BARO CH9/10
10	1252								1252
9	1146	1631	1631	1631	1631	1631	1631	1631	1146
8	1041	1463	1463	1463	1463	1463	1463	1463	1041
7	735	1314	1314	1314	1314	1314	*314	1314	735
6	631	1146	1146	1146	1146	1146	1146	1146	631
5	525	1000	1000	1000	1000	1000	1000	1000	525
4	420	631	631	631	631	631	631	631	420
3	314	463	463	463	463	463	463	463	314
2	210	315	315	315	315	315	315	315	210
1	104	146	146	146	146	146	146	146	104
0	0	0	0	0	0	0	0	0	0
-1	7674	7631	7631	7631	7631	7631	7631	7631	7674
2	7567	7463	7463	7463	7463	7463	7463	7463	7567
3	7463	7315	7315	7315	7315	7315	7315	7315	7463
4	7367	7146	7146	7146	7146	7146	7146	7146	7367
5	7253	7000	7000	7000	7000	7000	7000	7000	7253
-6	7146	6632	6632	6632	6632	6632	6632	6632	7146
7	7042	6463	6463	6463	6463	6463	6463	6463	7042
8	6736	6315	6315	6315	6315	6315	6315	6315	6736
9	6632	6147	6147	6147	6147	6147	6147	6147	6632
10	6526								6526
+FSC 1777	14.9950	9.9820	9.9820	9.9910	9.9910	9.9820	9.9910	9.9900	14.9800
FSC 6001	15.0040	-9.9980	9.9970	9.9970	9.9970	-9.9970	-9.9960	-9.9970	-14.9880

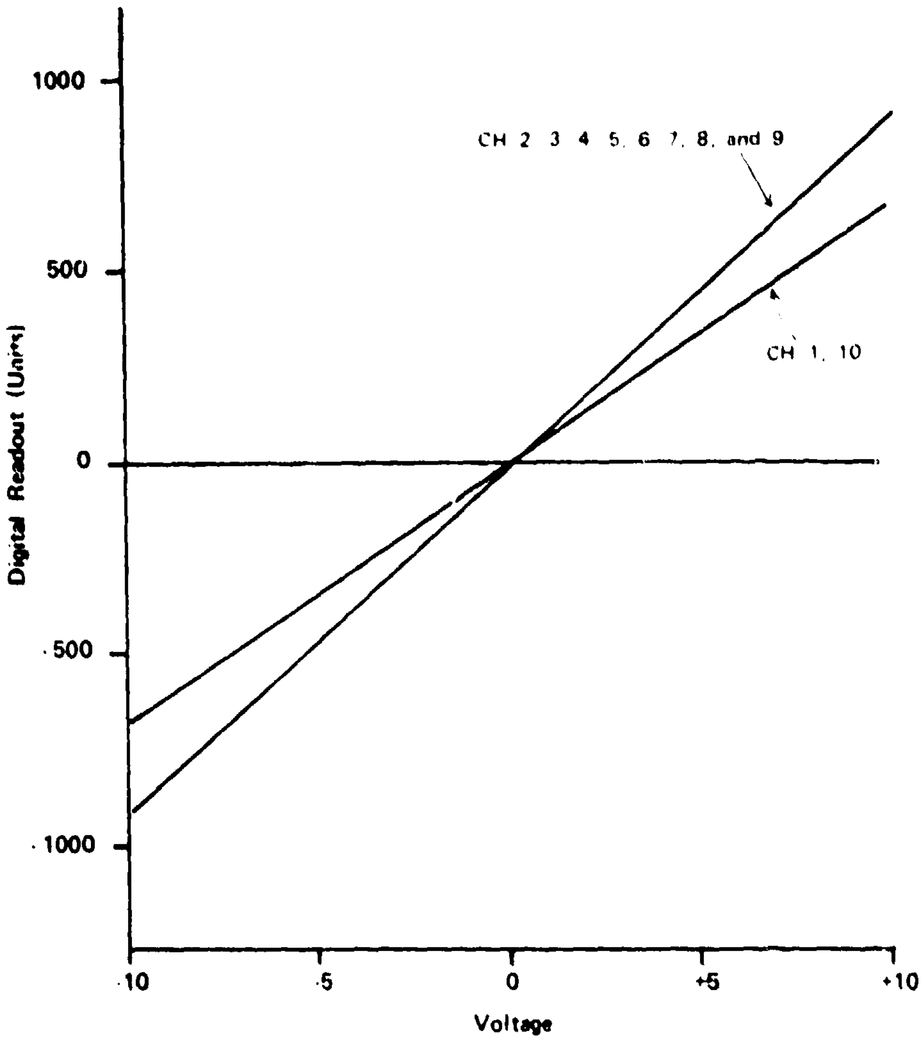


Figure 6-11. Functional Relationship of Analog Readings to the Digital Output of the A-D Channels.

C. PROGRAM LISTING

```
        *200
START,  CLA CLL
        DCA POIN
        TLS
        TAD BUF1
        DCA BUFPT
        JMS CRLF
        JMS TYPBUF
LOOP1,  TAD BUF2
        DCA BUFPT
        JMS TYPBUF
        TAD POIN
        IAC
        DCA POIN
        TAD POIN
        TAD K260
        JMS TYPE
        TAD POIN
        NOP
        TAD MOCH
        SZA CLA
        JMP LOOP1
        JMS CRLF
        TSF
        JMP .-1
        JMP I NEXT
        *240
CRLF,   0
        CLA CLL
        TAD K215
        JMS TYPE
        TAD K212
        JMS TYPE
        JMP I CRLF
        *250
TYPE,   0
        TSF
        JMP .-1
        TLS
        CLA CLL
        JMP I TYPE
        *260
TYPBUF, 0
        TAD I BUFPT
        SNA
        JMP I TYPBUF
        JMS TYPE
        ISZ BUFPT
        JMP .-5
        *273
POIN,   0
```

```
BUF1,   310
BUF2,   330
BUFPT,  0
MOCH,   7770
K260,   260
K215,   215
NEXT,   400
K212,   212
        *310
        307
        301
        311
        316
        240
        240
        326
        311
        316
        240
        240
        0
        *330
        240
        240
        240
        333
        310
        0
        *420
INEXT,  CLA CLL
        KCC
        TLS
        JMS I FINP
        JMS I FIX
        JMS I FFPUT
        GAIN
        JMS I FINP
        JMS I FIX
        JMS I FFPUT
        VCAL
        CLA CLL
        TAD K2
        DCA CHANN
        DCA LOC55
        TAD KM8
        DCA KONST
LOOP2,  DCA TEMP
        DCA TEMP+1
```

```
        DCA TEMP+2
        TAD GAIN
        TAD CHANN
        ADSC
        CLA CLL
        JMS AVERAG
        JMS I FFGET
        TEMP
        JMS I FOUT
        CLA CLL
        ISZ CHANN
        ISZ KONST
        JMP LOOP2
        IAC
        DCA LOC55
        JMS I FFGET
        ZERO
        JMS I FOUT
        TSF
        JMP .-1
        JMP INEXT
        *450
AVERAG, 0
        TAD KM100
        DCA CNT1
        TAD K2
        DCA TWO
        JMS I FFGET
        TWO
        JMS I FLOAT
        JMS I FFPUT
        TWO
LOOP3,  CLA CLL
        ADRC
        ADSF
        JMP .-1
        DCA MOMT
        JMS I FFGET
        MOMT
        JMS I FLOAT
        JMS I FFADD
        TEMP
        JMS I FDIVIDE
        TWO
        JMS I FFPUT
        TEMP
        CLA CLL
        ISZ CNT1
        JMP LOOP3
```

```
          JMP I AVERAG
          *510
          ADSC=6535
          ADRC=6536
          ADSF=6531
          *520
FINP,     6200
FIX,      5500
FFPUT,    7322
FFGET,    7306
FOUT,     5600
FLOAT,    5533
FFADD,    7000
FDIVIDE,6722
GAIN,     0
          0
          0
VCAL,     0
          0
          0
ZERO,     0
          0
        0
CHANN,    0
KM8,      7770
TEMP,     0
          0
          0
KM100,    7634
CNT1,     0
K2,       2
TWO,      0
          0
          0
MONT,     0
          0
          0
KONST,0
          *55
LOC55,    0
          1
          6
          0
          $
```

V. EQUATIONS

A linear relationship of the VDS analog signals was established for each of the tabulated measurements by a least square fit analysis. These derived functions are used for the calculations of in-flight performance by the computer program and for determining the necessary potentiometer adjustments (i.e., field elevation) required by a flight scenario. The least squares analysis provides the following information:

$y = a\,x + b$

where a: estimated slope
b: estimated offset
y: estimated dependent variable
x: independent variable

The independent variables for these measurements is the voltage reading and the dependent measurements are meter readings from the instruments or potentiometer settings.

The following equations were derived for each of the VDS analog signals:

1. Barometric Pressure

   On Board Baro

   $\hat{y} = (.0690)\ VBaro + 30.0174$

   $r^2 = .99989$

   Instructor's Pot

   $\hat{y} = (34.1731)\ VBaro + 599.4305$

   $r^2 = .9999$

2. Field Elevation

   Altimeter Reading

   $y = (-1343.9415)\ VAlt - 1.3233$

   $r^2 = .99996$

   Instructor's Pot

   $\hat{y} = (-311.6486)\ VAlt + 435.0885$

   $r^2 = .96677$

3. Altitude

   $\hat{y} = (-1343.7248)\ VAlt + 24.0151$

   $r^2 = .99999$

4. Indicated Airspeed

   $\hat{y} = (-15.4928)\ VIas + .64570$

   $r^2 = .99921$

5. Rate of Climb

Ascending

$\hat{y}$ = (-290.0602) Vrc + 4.1553

r^2 = -.99973

Decending

$\hat{y}$ = (282.1554) Vrc + 8.8701

r^2 = .99985

6. Wind Velocity

Pot Turns

$\hat{y}$ = (1.0357) VWvel - 0.0135

r^2 = .99994

7. A/D Calibration

Decimel Readout for channels 2, 3, 4, 5, 6, 7, and 8

$\hat{y}$ = (102.3714) Vin - 0.1708

r^2 = .99999

Decimal Readout for channels 1 and 10

$\hat{y}$ = (68.2134) Vin −0.2790

r^2 = .99999

VI. CALIBRATION CHECK WITH THE COMPUTER PROGRAM

A calibration check of the VDS analog signals can be done by using the computer program. This method is particularly useful for an individual with limited electronic skills and can also be used to check the computer calculations of the analog signals.

A. ALTITUDE

Check of this VDS signal is performed under the following conditions:

a. GAT--1 power ON.
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN.
c. Engine SHUT DOWN.
d. Parameter Switches on Supervisor's Console set to: LEVEL, VFR, DG, AIRSPEED 115 mph.
e. All cables to the computer from the GAT 1 Output Connector Panel at the back of the Supervisor's Console CONNECTED.

Step 1. Set the altimeter in the GAT for 0 feet. [The altimeter can be manually controlled by the pushbutton switches on the outside edge of the altitude card in the GAT. This card fits in slot J19, the seventh card from the right on the top rack in the tail section. The blue and green buttons, respectively, increases and decreases the altimeter readings. To freeze an altimeter setting, place the toggle switch above the pushbuttons in a downward position.]

Step 2. Set the attitude parameter switches on the supervisor's console to VFR and 0/0 feet.

Step 3. Run the short version of the computer program. A modified version of the parameter and scenario tapes have been made which shortens a computer-run to approximately one minute. Instructions on how to operate the computer and load the program are provided in Appendix D.

Step 4. Label the computer printout indicating the altimeter reading and the altitude parameter settings. The bottom figure of the altitude parameter settings are the VFR altitude values.

Step 5. Check the altimeter in the GAT. If any drift has occurred, reset altimeter to the correct reading.

Step 6. Change parameter switch on the supervisor's console to IFR. Run the program again. Label computer printout. The top figures of the altitude parameter setting are the IFR altitude values. For a quick operational check of the GAT–1 system, skip this step and do only step 7, 10, 13, and 14.

Step 7. Change the altimeter in the GAT to 2000 feet and repeat steps 2, 3, 4, 5, and 6.

Step 8. Set the altimeter parameter switch to VFR and 2000/1000 feet. Repeat steps 3, 4, 5, and 6.

Step 9. Set the altimeter parameter switches to VFR and 3000/2500 feet. Repeat steps 3, 4, 5, and 6.

Step 10. Change the altimeter in the GAT to 4000 feet and repeat steps 3, 4, 5, and 6.

Step 11. Set the altimeter parameter switches to VFR and 4000/3500 feet. Repeat steps 3, 4, 5, and 6.

Step 12. Set the altimeter switches to VFR and 5000/4000 feet. Repeat 3, 4, 5, and 6.

Step 13. Change the altimeter in the GAT to 0 feet and place the toggle switch in the upward position.

Step 14. Check the altitude calibrations. [Multiply the peak deviation in the fifth column by the unit value described in Appendix E, Data Output on TTY. The derived score should be equivalent to the difference between the altimeter reading and the altitude parameter setting (± 20 feet).] If any large discrepancies (greater than ± 20 feet) are noted, repeat the necessary steps to check for possible drift in the altimeter setting. Should the error persist, notify the proper personnel.

B. AIRSPEED

Check of this VDS signal is performed under the following conditions:

a. GAT–1 power on.
b. Servo Systems for Roll, Pitch, and Yaw SHUT DOWN.
c. Engine SHUT DOWN.
d. Parameter Switches on Supervisor's Console set to: LEVEL, VFR, ALTITUDE 0/0, and DG.
e. All cables to the computer from the GAT–1 Outputs Connector Panel located at the back of the supervisor's console CONNECTED.

Step 1. Set the airspeed parameter switch on the supervisor's console to 115 mph (100 knots).

Step 2. Change mechanical airspeed indicator to read 69 mph (60 knots). [The relative wind card has a switch which enables manual control of the airspeed by a 10-turn potentiometer. For manual control the switch must be placed in a downward position, and the pot adjusted (clockwise) until the airspeed indicator has the desired reading. Both the switch and the potentiometer are located on the outside edge of the card. This card fits in slot J20, the sixth card from the right on the top rack in the tail section. [Do steps 6, 7, 8, and 9 for a quick operational check of the GAT–1 system.]

Step 3. Run the short version of the computer program.

Step 4. Label the computer printout indicating the airspeed parameter switch setting and the mechanical indicated airspeed in the GAT.

Step 5. Change the mechanical airspeed indicator to read 95 mph (82 knots). Repeat steps 3 and 4.

Step 6. Change the mechanical airspeed indicator to read 115 mph (100 knots). Repeat steps 3 and 4.

Step 7. Change the mechanical airspeed indicator to read 138 mph (120 knots). Repeat steps 3 and 4.

Step 8. Reset mechanical airspeed indicator to 0 knots and place the toggle switch in the upward position.

Step 9. Check the airspeed calibrations. (Multiply the peak deviation in the fifth column by the unit value described in Appendix E, Data Output on TTY. The derived score should be equivalent to the distance between airspeed parameter setting and the mechanical airspeed indicator (± 3 knots).) The airspeed scores are in the units of knots and all calculations should be based on this unit. If any large discrepancies are noted (greater than ± 3 knots), recheck the measurement. Should the error persist, notify the proper personnel.

C. RATE OF CLIMB (ALTITUDE RATE OF CHANGE)

Check of this VDS signal is performed under the following conditions

a. GAT-1 power ON.
b. Servo Systems for Roll, and Yaw SHUT DOWN.
c. Servo System for Pitch ENERGIZED.
d. Engine ON.
e. Parameter Switches on Supervisor's Console set to VFR, ALTITUDE 0/0, AIRSPEED 95 mph, and DG.
f. All cables to the computer from the GAT-1 Outputs Connector Panel at the back of the Supervisor' Console CONNECTED.
g. CAUTION. Keep the altitude of the GAT between 0 and 10 000 feet.

Step 1. Set the altitude parameter switch on the supervisor's console to CLIMB

Step 2. In the GAT push in throttle and air mixture controls fully. Release parking brake (push in the control) and let airspeed build up to at least 80 mph

Step 3. Pull back on the yoke for a climb of approximately 500 feet minute as read by the Vertical Speed Indicator. Shut down the pitch servo system. (There will be a drift in the indicator reading. Use the trim tab located on the lower right side of the cockpit to change the pitch attitude so the desired reading (500 feet minute) can be obtained.)

Step 4. Run the short version of the computer program.

Step 5. Label the computer printout indicating the reading of the Vertical Speed Indicator

Step 6. Change the Vertical Speed Indicator to read 600 feet minute climb and repeat steps 4 and 5. Use the trim tab to change the pitch attitude

Step 7. Change the Vertical Speed Indicator to read 400 feet/minute climb and repeat steps 4 and 5.

Step 8. Turn on the pitch servo system; change the pitch attitude until a 500 feet/minute descent is obtained on the Vertical Speed Indicator. Turn off the pitch servo system, and use the trim tab to obtain the desired reading. Repeat steps 3, 4, 5, 6, and 7 using a descending pitch attitude.

Step 9. Bring the GAT–1 to ground level and put the trim tab to the neutral position. Pull on the brake; turn off the engine and shut down the pitch servo system.

Step 10. Check the rate of climb calibrations. [Multiply the peak deviation in the fifth column by the unit value described in Appendix E, Data Output on TTY. The derived score should be equivalent to the difference between 500 feet/minute and the Vertical Speed Indicator reading (± 10 feet/minute).] If any large discrepancies are noted (greater than ± 10 feet/minute), recheck the measurements. Should the error persist, notify the proper personnel.

D. HEADING

Check of this VDS signal is performed under the following conditions.

a. GAT–1 power ON.

b. Servo Systems for Pitch and Roll SHUT DOWN.

c. Servo System for Yaw ENERGIZED.

d. Engine ON

e. Parameter Switch on Supervisor' Console set to: LEVEL, VFR, ALTITUDE 0 0, and AIRSPEED 115 mph.

f. All cables to the computer from the GAT–1 Output Connector Panel at the back of the Supervisor's Console CONNECTED.

Step 1. Set the heading parameter switch to DG (Directional Gyro) and the thumbwheel switch to 000.

Step 2. In the GAT, push in throttle and air mixture controls fully. Release the parking brake (push in the control). This procedure enables the airspeed to increase from zero which is necessary for rudder control of the yaw motion system.

Step 3. Set the Directional Gyro Indicator to read North by using the rudder pedals and shut down the yaw servo system.

Step 4. Run the short version of the computer program.

Step 5. Label the computer printout indicating the Directional Gyro reading and the heading parameter settings.

Step 6. Set the Directional Gyro Indicator to read East.

Step 7. Repeat steps 4 and 5.

Step 8. Set the Directional Gyro Indicator to read South.

Step 9. Repeat steps 4 and 5.

Step 10. Set the Directional Gyro Indicator to read West.

Step 11. Repeat steps 4 and 5.

Step 12. Pull out throttle , air mixture and brake controls. Shut down the yaw servo system.

Step 13. Check the heading calibrations. [Multiply the peak deviation in the fifth column by the unit value described in Appendix E, Data Output on TTY. The derived score should be equivalent to the difference between the Directional Gyro Indication and the thumbwheel switch heading with the following exception. If the difference between the Directional Gyro Indication and the thumbwheel switches is over 180°, that value should be subtracted from 360° before being compared to the derived data output score. This step is necessary, since the scores are deviation measures and the greatest heading error that can occur is 180°.]

E. VOR DEVIATION

Check of this VDS signal is performed under the following conditions:

a. GAT–1 power ON.

b. Servo Systems for Pitch, Roll, and Yaw SHUT DOWN.

c. Engine SHUT DOWN.

d. MARK 12A Panel ON (upper knob on left half of panel).

e. Parameter Switches on Supervisor's Console set to: LEVEL, VFR, ALTITUDE 0/0, and AIRSPEED 115 mph.

f. All cables to the computer from the GAT–1 Output Connector Panel at the back of the Supervisor's Console CONNECTED.

g. CAUTION The magnetic heading may not be the same as true North. Use the VOR radials of the X–Y plotter map when slewing the aircraft.

Step 1. Set the heading parameter switch on the Supervisor's Console to VOR (VHF Omnidirectional Radio Range).

Step 2. Slew the GAT–1 due south (3 inches) of a VOR station (180° radial) using the slew switches on the X–Y plotter.

Step 3. In the GAT, set the OMNI bearing selector (outer dial) to 0° using the knob at the base of the VOR instrument. The VOR course indicator should read TO station and the course deviation indicator needle should be in a vertical position with 180° at the top and 0° at the bottom.

Step 4. Run the short version of the computer program.

Step 5. Label the computer printout indicating the number of degrees difference from the OMNI bearing selector reading when the course deviation indicator is in a true vertical position.

Step 6. Repeat steps 4 and 5 with OMNI bearing selector readings of 1°, 2°, 5°, 40°, 320°, 355°, 358°, and 359°. Use only one of these readings for a quick operational check of the GAT-1 system.

Step 7. Change the OMNI bearing selector to 180°. The VOR course indicator should read FROM station and the course deviation indicator needle should be in a vertical position with 0° at the top and 180° at the bottom.

Step 8. Repeat steps 4 and 5 with the OMNI bearing selector readings of 180°, 179°, 178°, 175°, 140°, 220°, 185°, 182° and 181°. Use 180° and one other reading for a quick operational check of the GAT–1 system.

Step 9. Check the VOR calibrations. [Multiply the peak deviation in the fifth column by the unit value described in Appendix E, Data Output on TTY. The derived score should be equivalent to the difference of the OMNI bearing selector reading from 0° when the course deviation needle reads TO, or the difference of the OMNI bearing selector reading from 180° when the course deviation needle reads FROM.]

JUNCTION BOX

I. DESCRIPTION

All digital I/O signal distribution, processing, buffering, and switching are implemented in the Junction Box. The Junction Box, external to the computer, is located on the lower back side of the Supervisor's console. A meshed cover has been placed over the panel for protection and safety.

There are a total of 64 modules in the Junction Box which are divided into two groups of 32 modules. Figure 7-1 shows the design layout of the modules in the Junction Box. The modules consist of DEC M112 NOR Gates (10/card), DEC M111 Inverters (16/card), DEC M050 Drivers (12/card), DEC M040 Solenoid Drivers (2/card), Relay system constructed by Transportation Systems Center using C.P. Clare and Company relays (2/card), and DEC M953B External Bus Cable Connectors. Figure 7-2 illustrates how these systems have been functionally hardwired. Currently, the only wiring configuration of concern are those for the slide control channels and the cable connectors that emanate from or terminate at the Junction Box.

II. JUNCTION BOX BACKPLANE WIRING

The following pages contain all the wiring connections and pin assignments of the modules that have been hardwired. All digital signals presently being used are identified by name. For a more detailed description of the routing for a particular signal see the section entitled Digital Signals (Section V).

Slot	Module	Slot	Module
1		33	
2		34	
3	ONE SHOT DET BUTTON IN GAT	35	
4		36	
5	C-3 CABLE CONN FROM DC52-J1	37	C4 - CABLE CONN - FROM DC54-J1
6	DEC M112 - NOR GATES (10)	38	DEC M112 - NOR GATES (10)
7	DEC M112 - NOR GATES (10)	39	DEC M112 - NOR GATES (10)
8	DEC M112 - NOR GATES (10)	40	DEC M112 - NOR GATES (10)
9	DEC M112 - NOR GATES (10)	41	DEC M112 - NOR GATES (10)
10	DEC M112 - NOR GATES (10)	42	DEC M112 - NOR GATES (10)
11		43	
12	DEC M111 - INVERTERS (16)	44	DEC M111 - INVERTERS (16)
13	DEC M111 - INVERTERS (16)	45	DEC M111 - INVERTERS (16)
14	DEC M111 - INVERTERS (16)	46	DEC M111 - INVERTERS (16)
15	DEC M111 - INVERTERS (16)	47	DEC M111 - INVERTERS (16)
16	DEC M111 - INVERTERS (16)	48	DEC M111 - INVERTERS (16) SL ADV & SL SK
17		49	
18	DEC M050 - DRIVERS (12)	50	DEC M050 - DRIVERS (12)
19	DEC M050 - DRIVERS (12)	51	DEC M050 - DRIVERS (12)
20	DEC M050 - DRIVERS (12)	52	DEC M050 - DRIVERS (12)
21	DEC M050 - DRIVERS (12)	53	DEC M050 - DRIVERS (12)
22	DEC M050 - DRIVERS (12)	54	DEC M050 - DRIVERS (12)
23		55	
24		56	
25		57	
26		58	
27	C1 CABLE CONN - TO DC50-J2 Start Stop,Cont & Det Det ER DS13,14	59	C6 CABLE CONN FROM DC55-J1
28	C2 CABLE CONN TO DC51-J2 DET SECTORS 1-12	60	C8 CABLE CONN FROM DC56-J1
29	C14 CABLE CONN TO STOP CONS & PROJ Slides(4) DET Sectors 1-14 Stop Start Cont	61	TSC RELAY MODULE (2) SL ADV RGT & SL ADV LFT
30	C15 CABLE CONN TO STOP CONS & PROJ FLIGHT PARAMETERS & SLIDES	62	TSC RELAY MODULE (2) SK EV & SK OD
31	C5 CABLE CONN TO DC55-J2 FLIGHT PARAMETERS, SUSPEND	63	DEC M040 SOLENOID DRIVERS (2) SL ADV RGT & SL SK OD
32	C7 CABLE CONN TO DC56-J2 FLIGHT PARAMETERS	64	DEC M040 SOLENOID DRIVERS (2) SL ADV LFT & SK EV

NOTE: View from inside instructor's console

Figure 7-1. Junction Box Modules

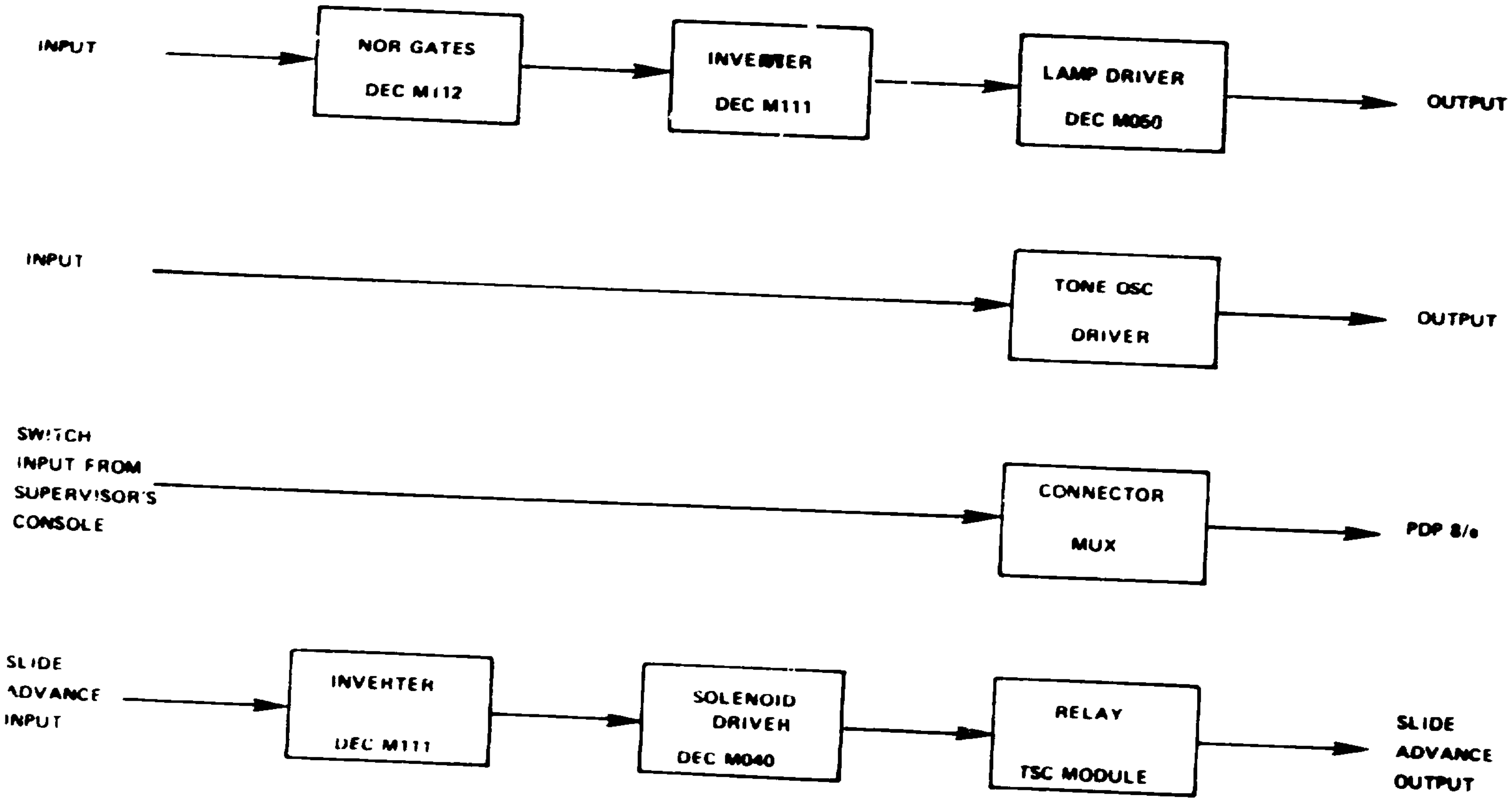


Figure 7.2 Functional Layout of Junction Box

JUNCTION BOX BACKPLANE WIRING

SLOT 3

FROM		TO	SIGNAL
SLOT	PIN		
3	A1	NC	
	A2	NC	
	B1	NC	
	B2	NC	
	C1	NC	
	C2	NC	
	D1	NC	
	D2	NC	
	E1	NC	
	E2	SLOT 27, PIN J1	DETECT BUTTON
	F1	NC	
	F2	NC	
	H1	NC	
	H2	NC	
	J1	NC	
	J2	NC	
	K1	NC	
	K2	NC	
	L1	NC	
	L2	NC	
	M1	NC	
	M2	NC	
	N1	NC	
	N2	NC	
	P1	NC	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	NC	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 5 C3

FROM		TO	SIGNAL
SLOT	PIN		
5	A1	GND	
	A2	NC	
	B1	SLOTS 6 - 10 & 38 - 42 PIN A1	
	B2	NC	
	C1	GND	
	C2	GND	
	D1	SLOTS 6 10 & 38 42 PIN H1	
	D2	SLOTS 6 10 & 38 42 PIN D1	
	E1	SLOTS 6 10 & 38 42 PIN P1	
	E2	SLOTS 6 10 & 38 42 PIN L1	
	F1	GND	
	F2	GND	
	H1	SLOTS 6 10 & 38 42 PIN H2	
	H2	SLOTS 6 10 & 38 42 PIN D2	
	J1	SLOTS 6 10 & 38 42 PIN P2	
	J2	GND	
	K1	GND	
	K2	SLOTS 6 10 & 38 42 PIN L2	
	L1	NC	
	L2	GND	
	M1	NC	
	M2	SLOTS 6 10 & 38 42 PIN T2	
	N1	GND	
	N2	GND	
	P1	NC	
	P2	NC	
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 6:M112

FROM SLOT	FROM PIN	TO	SIGNAL
6	A1	SLOT 5, PIN B1	
	A2	5 VDC	
	B1	SLOT 37, PIN B1	
	B2	NC	
	C1	SLOT 12, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN B1	
	E2	SLOT 37, PIN B1	
	F1	SLOT 12, PIN D1	
	F2	SLOT 12, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN B1	
	J2	SLOT 37, PIN B1	
	K1	SLOT 12, PIN E2	
	K2	SLOT 12, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN B1	
	M2	SLOT 37, PIN B1	
	N1	SLOT 12, PIN F1	
	N2	SLOT 12, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN B1	
	R2	SLOT 37, PIN B1	
	S1	SLOT 12, PIN H2	
	S2	SLOT 12, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN B1	
	V1		
	V2	SLOT 12, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 7:M112

FROM		TO	SIGNAL
SLOT	PIN		
7	A1	SLOT 5, PIN B1	
	A2	5 VDC	
	B1	SLOT 37, PIN D2	
	B2	NC	
	C1	SLOT 13, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN D2	
	E2	SLOT 37, PIN D2	
	F1	SLOT 13, PIN D1	
	F2	SLOT 13, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN D2	
	J2	SLOT 37, PIN D2	
	K1	SLOT 13, PIN E2	
	K2	SLOT 13, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN D2	
	M2	SLOT 37, PIN D2	
	N1	SLOT 13, PIN F1	
	N2	SLOT 13, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN D2	
	R2	SLOT 37, PIN D2	
	S1	SLOT 13, PIN H2	
	S2	SLOT 13, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN D2	
	V1		
	V2	SLOT 13, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 8:M112

FROM SLOT	FROM PIN	TO	SIGNAL
8	A1	SLOT 5, PIN B1	
	A2	5 VDC	
	B1	SLOT 37, PIN D1	
	B2	NC	
	C1	SLOT 14, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN D1	
	E2	SLOT 37, PIN D1	
	F1	SLOT 14, PIN D1	
	F2	SLOT 14, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN D1	
	J2	SLOT 37 PIN D1	
	K1	SLOT 14, PIN E2	
	K2	SLOT 14, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5 PIN K2	
	M1	SLOT 37 PIN D1	
	M2	SLOT 37, PIN D1	
	N1	SLOT 14 PIN F1	
	N2	SLOT 14, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5 PIN J1	
	R1	SLOT 37 PIN D1	
	R2	SLOT 37 PIN D1	
	S1	SLOT 14 PIN H2	
	S2	SLOT 14, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37 PIN D1	
	V1		
	V2	SLOT 14, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 9:M112

FROM		TO	SIGNAL
SLOT	PIN		
9	A1	SLOT 5, PIN B1	
	A2	5 VDC	
	B1	SLOT 37, PIN E2	
	B2	NC	
	C1	SLOT 15, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN E2	
	E2	SLOT 37, PIN E2	
	F1	SLOT 15, PIN D1	
	F2	SLOT 15, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN E2	
	J2	SLOT 37, PIN E2	
	K1	SLOT 15, PIN E2	
	K2	SLOT 15, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN E2	
	M2	SLOT 37, PIN E2	
	N1	SLOT 15, PIN F1	
	N2	SLOT 15, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN E2	
	R2	SLOT 37, PIN E2	
	S1	SLOT 15, PIN H2	
	S2	SLOT 15, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN E2	
	V1		
	V2	SLOT 15, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 10:M112

FROM		TO	SIGNAL
SLOT	PIN		
10	A1	SLOT 5, PIN B1	
	A2	5 VDC	
	B1	SLOT 37, PIN E1	
	B2	NC	
	C1	SLOT 16, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN E1	
	E2	SLOT 37, PIN E1	
	F1	SLOT 16, PIN D1	
	F2	SLOT 16, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN E1	
	J2	SLOT 37, PIN E1	
	K1	SLOT 16, PIN E2	
	K2	SLOT 16, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN E1	
	M2	SLOT 37, PIN E1	
	N1	SLOT 16, PIN F1	
	N2	SLOT 16, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN E1	
	R2	SLOT 37, PIN E1	
	S1	SLOT 16, PIN H2	
	S2	SLOT 16, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN F1	
	V1		
	V2	SLOT 16, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 12:M111

FROM		TO	SIGNAL
SLOT	PIN		
12	A1	NC	
	A2	5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 6, PIN C1	
	C2	GND	
	D1	SLOT 6, PIN F1	
	D2	SLOT 18, PIN D2	
	E1	SLOT 18, PIN E2	
	E2	SLOT 6, PIN K1	
	F1	SLOT 6, PIN N1	
	F2	SLOT 18, PIN F2	
	H1	SLOT 18, PIN H2	
	H2	SLOT 6, PIN S1	
	J1	SLOT 6, PIN F2	
	J2	SLOT 18, PIN J2	
	K1	SLOT 18, PIN K2	
	K2	SLOT 6, PIN K2	
	L1	SLOT 6, PIN N2	
	L2	SLOT 18, PIN L2	
	M1	SLOT 18, PIN M2	
	M2	SLOT 6, PIN S2	
	N1	SLOT 6, PIN V2	
	N2	SLOT 18, PIN N2	
	P1	SLOT 18, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 13:M111

FROM		TO	SIGNAL
SLOT	PIN		
13	A1	NC	
	A2	5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 7, PIN C1	
	C2	GND	
	D1	SLOT 7, PIN F1	
	D2	SLOT 19, PIN D2	
	E1	SLOT 19, PIN E2	
	E2	SLOT 7, PIN K1	
	F1	SLOT 7, PIN N1	
	F2	SLOT 19, PIN F2	
	H1	SLOT 19, PIN H2	
	H2	SLOT 7, PIN S1	
	J1	SLOT 7, PIN F2	
	J2	SLOT 19, PIN J2	
	K1	SLOT 19, PIN K2	
	K2	SLOT 7, PIN K2	
	L1	SLOT 7, PIN N2	
	L2	SLOT 19, PIN L2	
	M1	SLOT 19, PIN M2	
	M2	SLOT 7, PIN S2	
	N1	SLOT 7, PIN V2	
	N2	SLOT 19, PIN N2	
	P1	SLOT 19, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 14:M111

FROM		TO	SIGNAL
SLOT	PIN		
14	A1	NC	
	A2	5VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 8, PIN C1	
	C2	GND	
	D1	SLOT 8, PIN F1	
	D2	SLOT 20, PIN D2	
	E1	SLOT 20, PIN E2	
	E2	SLOT 8, PIN K1	
	F1	SLOT 8, PIN N1	
	F2	SLOT 20, PIN F2	
	H1	SLOT 20, PIN H2	
	H2	SLOT 8, PIN S1	
	J1	SLOT 8, PIN F2	
	J2	SLOT 20, PIN J2	
	K1	SLOT 20, PIN K2	
	K2	SLOT 8, PIN K2	
	L1	SLOT 8, PIN N2	
	L2	SLOT 20, PIN L2	
	M1	SLOT 20, PIN M2	
	M2	SLOT 8, PIN S2	
	N1	SLOT 8, PIN V2	
	N2	SLOT 20, PIN N2	
	P1	SLOT 20, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 15:M111

FROM SLOT	FROM PIN	TO	SIGNAL
15	A1	NC	
	A2	5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 9, PIN C1	
	C2	GND	
	D1	SLOT 9, PIN F1	
	D2	SLOT 21, PIN D2	
	E1	SLOT 21, PIN E2	
	E2	SLOT 9, PIN K1	
	F1	SLOT 9, PIN N1	
	F2	SLOT 21, PIN F2	
	H1	SLOT 21, PIN H2	
	H2	SLOT 9, PIN S1	
	J1	SLOT 9, PIN F2	
	J2	SLOT 21, PIN J2	
	K1	SLOT 21, PIN K2	
	K2	SLOT 9, PIN K2	
	L1	SLOT 9, PIN N2	
	L2	SLOT 21, PIN L2	
	M1	SLOT 21, PIN M2	
	M2	SLOT 9, PIN S2	
	N1	SLOT 9, PIN V2	
	N2	SLOT 21, PIN N2	
	P1	SLOT 21, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 16:M111

FROM		TO	SIGNAL
SLOT	PIN		
16	A1	NC	
	A2	5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 10, PIN C1	
	C2	GND	
	D1	SLOT 10, PIN F1	
	D2	SLOT 22, PIN D2	
	E1	SLOT 22, PIN E2	
	E2	SLOT 10, PIN K1	
	F1	SLOT 10, PIN N1	
	F2	SLOT 22, PIN F2	
	H1	SLOT 22, PIN H2	
	H2	SLOT 10, PIN S1	
	J1	SLOT 10, PIN F2	
	J2	SLOT 22, PIN J2	
	K1	SLOT 22, PIN K2	
	K2	SLOT 10, PIN K2	
	L1	SLOT 10, PIN N2	
	L2	SLOT 22, PIN L2	
	M1	SLOT 22, PIN M2	
	M2	SLOT 10, PIN S2	
	N1	SLOT 10, PIN N2	
	N2	SLOT 22, PIN N2	
	P1	SLOT 22, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 18:M050

FROM		TO	SIGNAL
SLOT	PIN		
18	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	- 15 VDC	
	C1	NC	
	C2	GND	
	D1		
	D2	SLOT 12, PIN D2	
	E1		
	E2	SLOT 12, PIN E1	
	F1		
	F2	SLOT 12, PIN F2	
	H1		
	H2	SLOT 12, PIN H1	
	J1		
	J2	SLOT 12, PIN J2	
	K1		
	K2	SLOT 12, PIN K1	
	L1	SLOT 24, PIN A1	
	L2	SLOT 12, PIN L2	
	M1	SLOT 24, PIN B1	
	M2	SLOT 12, PIN M1	
	N1	SLOT 24, PIN C1	
	N2	SLOT 12, PIN N2	
	P1	SLOT 24, PIN D1	
	P2	SLOT 12, PIN P1	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 19:M050

FROM		TO	SIGNAL
SLOT	PIN		
19	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	-15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 24, PIN D2	
	D2	SLOT 13, PIN D2	
	E1	SLOT 24, PIN E1	
	E2	SLOT 13, PIN E1	
	F1	SLOT 24, PIN E2	
	F2	SLOT 13, PIN F2	
	H1	SLOT 24, PIN F1	
	H2	SLOT 13, PIN H1	
	J1	SLOT 24, PIN F2	
	J2	SLOT 13, PIN J2	
	K1	SLOT 24, PIN H1	
	K2	SLOT 13, PIN K1	
	L1	SLOT 24, PIN H2	
	L2	SLOT 13, PIN L2	
	M1	SLOT 24, PIN J1	
	M2	SLOT 13, PIN M1	
	N1	SLOT 24, PIN J2	
	N2	SLOT 13, PIN N2	
	P1	SLOT 24, PIN K1	
	P2	SLOT 13, PIN P1	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 20 M060

FROM		TO	SIGNAL
SLOT	PIN		
20	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	-15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 24, PIN K2	
	D2	SLOT 14, PIN D2	
	E1	SLOT 24, PIN L1	
	E2	SLOT 14, PIN E1	
	F1	SLOT 24, PIN L2	
	F2	SLOT 14, PIN F2	
	H1	SLOT 24, PIN M1	
	H2	SLOT 14, PIN H1	
	J1	SLOT 24, PIN M2	
	J2	SLOT 14, PIN J2	
	K1	SLOT 24, PIN N1	
	K2	SLOT 14, PIN K1	
	L1	SLOT 24, PIN N2	
	L2	SLOT 14, PIN L2	
	M1	SLOT 24, PIN P1	
	M2	SLOT 14, PIN M1	
	N1	SLOT 24, PIN P2	
	N2	SLOT 14, PIN N2	
	P1	SLOT 24, PIN R1	
	P2	SLOT 14, PIN P1	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 21 M050

FROM		TO	SIGNAL
SLOT	PIN		
21	A1	NC	
	A2	5 VDC	
	B1	NC	
	B2	-15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 24, PIN R2	
	D2	SLOT 15, PIN D2	
	E1	SLOT 24, PIN S1	
	E2	SLOT 15, PIN E1	
	F1	SLOT 24, PIN S2	
	F2	SLOT 15, PIN F2	
	H1	SLOT 24, PIN T2	
	H2	SLOT 15, PIN H1	
	J1	SLOT 24, PIN U1	
	J2	SLOT 15, PIN J2	
	K1	SLOT 24, PIN U2	
	K2	SLOT 15, PIN K1	
	L1	SLOT 24, PIN V1	
	L2	SLOT 15, PIN L2	
	M1	SLOT 24, PIN V2	
	M2	SLOT 15, PIN M1	
	N1	SLOT 25, PIN A1	
	N2	SLOT 15, PIN N2	
	P1	SLOT 25, PIN B1	
	P2	SLOT 15, PIN P1	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 22:M050

FROM		TO	SIGNAL
SLOT	PIN		
22	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 25 PIN C1	
	D2	SLOT 16 PIN D2	
	E1	SLOT 25 PIN D1	
	E2	SLOT 16 PIN E1	
	F1	SLOT 25 PIN D2	
	F2	SLOT 16 PIN F2	
	H1	SLOT 25 PIN E1	
	H2	SLOT 16 PIN H1	
	J1	SLOT 25 PIN E2	
	J2	SLOT 16 PIN J2	
	K1	SLOT 25 PIN F1	
	K2	SLOT 16 PIN K1	
	L1	SLOT 25 PIN F2	
	L2	SLOT 16 PIN L2	
	M1	SLOT 25 PIN H1	
	M2	SLOT 16 PIN M1	
	N1	SLOT 25 PIN H2	
	N2	SLOT 16 PIN N2	
	P1	SLOT 25 PIN J1	
	P2	SLOT 16 PIN P1	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 24

FROM		TO	SIGNAL
SLOT	PIN		
24	A1	SLOT 18, PIN L1	
	A2	NC	
	B1	SLOT 18, PIN M1	
	B2	NC	
	C1	SLOT 18, PIN N1	
	C2	GND	
	D1	SLOT 18, PIN P1	
	D2	SLOT 19, PIN D1	
	E1	SLOT 19, PIN E1	
	E2	SLOT 19, PIN F1	
	F1	SLOT 19, PIN H1	
	F2	SLOT 19, PIN J1	
	H1	SLOT 19, PIN K1	
	H2	SLOT 19, PIN L1	
	J1	SLOT 19, PIN M1	
	J2	SLOT 19, PIN N1	
	K1	SLOT 19, PIN P1	
	K2	SLOT 20, PIN D1	
	L1	SLOT 20, PIN E1	
	L2	SLOT 20, PIN F1	
	M1	SLOT 20, PIN H1	
	M2	SLOT 20, PIN J1	
	N1	SLOT 20, PIN K1	
	N2	SLOT 20, PIN L1	
	P1	SLOT 20, PIN M1	
	P2	SLOT 20, PIN N1	
	R1	SLOT 20, PIN P1	
	R2	SLOT 21, PIN D1	
	S1	SLOT 21, PIN E1	
	S2	SLOT 21, PIN F1	
	T1	GND	
	T2	SLOT 21, PIN H1	
	U1	SLOT 21, PIN J1	
	U2	SLOT 21 PIN K1	
	V1	SLOT 21, PIN L1	
	V2	SLOT 21, PIN M1	

JUNCTION BOX BACKPLANE WIRING

SLOT 25

FROM		TO	SIGNAL
SLOT	PIN		
25	A1	SLOT 21, PIN N1	
	A2	NC	
	B1	SLOT 21, PIN P1	
	B2	NC	
	C1	SLOT 22, PIN D1	
	C2	GND	
	D1	SLOT 22, PIN E1	
	D2	SLOT 22, PIN F1	
	E1	SLOT 22, PIN H1	
	E2	SLOT 22, PIN J1	
	F1	SLOT 22, PIN K1	
	F2	SLOT 22, PIN L1	
	H1	SLOT 22, PIN M1	
	H2	SLOT 22, PIN N1	
	J1	SLOT 22, PIN P1	
	J2	SLOT 50, PIN D1	
	K1	SLOT 50, PIN E1	
	K2	SLOT 50, PIN F1	
	L1	SLOT 50 PIN H1	
	L2	SLOT 50, PIN J1	
	M1	SLOT 50, PIN K1	
	M2	SLOT 50, PIN L1	
	N1	SLOT 50, PIN M1	
	N2	SLOT 50, PIN N1	
	P1	SLOT 50, PIN P1	
	P2	SLOT 51, PIN D1	
	R1	SLOT 51, PIN E1	
	R2	SLOT 51, PIN F1	
	S1	SLOT 51, PIN H1	
	S2	SLOT 51, PIN J1	
	T1	GND	
	T2	SLOT 51, PIN K1	
	U1	SLOT 51, PIN L1	
	U2	SLOT 51, PIN M1	
	V1	SLOT 51, PIN N1	
	V2	SLOT 51, PIN P1	

JUNCTION BOX BACKPLANE WIRING

SLOT 27 C1

FROM		TO	SIGNAL
SLOT	PIN		
27	A1	GND	
	A2	NC	
	B1	SLOT 29, PIN A1	START
	B2	NC	
	C1	GND	
	C2	GND	
	D1	SLOT 29, PIN B1	CONT
	D2	SLOT 29, PIN C1	STOP
	E1	NC	
	E2	NC	
	F1	GND	
	F2	GND	
	H1	NC	
	H2	NC	
	I1	C16 COAX CABLE	DETECT BUTTON
	J2	GND	
	K1	GND	
	K2	NC	
	L1	SLOT 29, PIN D1	DETECT SECTOR 13
	L2	GND	
	M1	NC	
	M2	SLOT 29, PIN D2	DETECT ERROR
	N1	GND	
	N2	GND	
	P1	NC	
	P2	SLOT 29, PIN E1	DETECT SECTOR 14
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 28:C2

FROM		TO	SIGNAL
SLOT	PIN		
28	A1	GND	
	A2	NC	
	B1	SLOT 29, PIN E2	DETECT SECTOR 1
	B2	NC	
	C1	GND	
	C2	GND	
	D1	SLOT 29, PIN F2	DETECT SECTOR 3
	D2	SLOT 29, PIN H1	DETECT SECTOR 2
	E1	SLOT 29, PIN H2	DETECT SECTOR 5
	E2	SLOT 29, PIN J1	DETECT SECTOR 4
	F1	GND	
	F2	GND	
	H1	SLOT 29, PIN J2	DETECT SECTOR 7
	H2	SLOT 29, PIN K1	DETECT SECTOR 6
	J1	SLOT 29, PIN K2	DETECT SECTOR 9
	J2	GND	
	K1	GND	
	K2	SLOT 29, PIN L2	DETECT SECTOR 8
	L1	SLOT 29, PIN M1	DETECT SECTOR 11
	L2	GND	
	M1	NC	
	M2	SLOT 29, PIN M2	DETECT SECTOR 10
	N1	GND	
	N2	GND	
	P1	NC	
	P2	SLOT 29, PIN N1	DETECT SECTOR 12
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 29:C14

FROM		TO	SIGNAL
SLOT	PIN		
29	A1	SLOT 27, PIN B1	START
	A2	NC	
	B1	SLOT 27, PIN D1	CONTINUE
	B2	NC	
	C1	SLOT 27, PIN D2	STOP
	C2	GND	
	D1	SLOT 27, PIN L1	DETECT SECTOR 13
	D2	SLOT 27, PIN M2	DETECT ERROR
	E1	SLOT 27, PIN P2	DETECT SECTOR 14
	E2	SLOT 28, PIN B1	DETECT SECTOR 1
	F1	GND	
	F2	SLOT 28, PIN D1	DETECT SECTOR 3
	H1	SLOT 28, PIN D2	DETECT SECTOR 2
	H2	SLOT 28, PIN E1	DETECT SECTOR 5
	J1	SLOT 28, PIN E2	DETECT SECTOR 4
	J2	SLOT 28, PIN H1	DETECT SECTOR 7
	K1	SLOT 28, PIN H2	DETECT SECTOR 6
	K2	SLOT 28, PIN J1	DETECT SECTOR 9
	L1	GND	
	L2	SLOT 28, PIN K2	DETECT SECTOR 8
	M1	SLOT 28, PIN L1	DETECT SECTOR 11
	M2	SLOT 28, PIN L2	DETECT SECTOR 10
	N1	SLOT 28, PIN P2	DETECT SECTOR 12
	N2		
	P1	GND	
	P2		
	R1		
	R2	GND	
	S1		
	S2		
	T1	GND	
	T2		
	U1		
	U2		
	V1		
	V2	GND	

JUNCTION BOX BACKPLANE WIRING

SLOT 30:C15

FROM		TO	SIGNAL
SLOT	PIN		
30	A1	SLOT 31, PIN B1	AIRSPEED 1 (95 MPH)
	A2	NC	
	B1	SLOT 31, PIN D1	
	B2	NC	
	C1	SLOT 31, PIN D2	SUSPEND
	C2	GND	
	D1	SLOT 31, PIN E1	AIRSPEED 2 (115 MPH)
	D2	SLOT 31, PIN E2	
	E1	SLOT 31, PIN H1	ALTITUDE 1 (0/0)
	E2	SLOT 31, PIN H2	
	F1	GND	
	F2	SLOT 31, PIN J1	ALTITUDE 3 (2500/3000)
	H1	SLOT 31, PIN K2	ALTITUDE 2 (1000/2000)
	H2	SLOT 31, PIN L1	ALTITUDE 5 (4500/5000)
	J1	SLOT 31, PIN M2	ALTITUDE 4 (3500/4000)
	J2	SLOT 31, PIN P2	IFR/VFR
	K1	SLOT 32, PIN B1	DG/VOR
	K2	SLOT 32, PIN D1	BCD UNITS, 2^1
	L1	GND	
	L2	SLOT 32, PIN D2	BCD UNITS, 2^0
	M1	SLOT 32, PIN E1	BCD UNITS, 2^3
	M2	SLOT 32, PIN E2	BCD UNITS, 2^2
	N1	SLOT 32, PIN H1	BCD TENS, 2^1
	N2	SLOT 32, PIN H2	BCD TENS, 2^0
	P1	SLOT 62, PIN M2	SK OD
	P2	SLOT 32, PIN J1	BCD TENS, 2^3
	R1	SLOT 32, PIN K2	BCD TENS, 2^2
	R2	SLOT 32, PIN L1	BCD 100's, 2^1
	S1	SLOT 32, PIN M2	BCD 100's, 2^0
	S2	SLOT 32, PIN P2	LEVEL CLIMB
	T1	GND	
	T2	SLOT 61 (D2)	COMMON (ALL REL)
	U1	SLOT 81, PIN E2	SL ADV LFT
	U2	SLOT 61, PIN E2	SK EV
	V1	SLOT 61, PIN M2	SL ADV RGT
	V2	GND	

JUNCTION BOX BACKPLANE WIRING

SLOT 31 C5

FROM		TO	SIGNAL
SLOT	PIN		
31	A1	GND	
	A2	NC	
	B1	SLOT 30, PIN A1	AIRSPEED 1 (96 MPH)
	B2	NC	
	C1	GND	
	C2	GND	
	D1	SLOT 30, PIN B1	
	D2	SLOT 30, PIN C1	SUSPEND
	E1	SLOT 30, PIN D1	AIRSPEED 2 (115 MPH)
	E2	SLOT 30, PIN D2	
	F1	GND	
	F2	GND	
	H1	SLOT 30, PIN E1	ALTITUDE 1
	H2	SLOT 30, PIN E2	
	J1	SLOT 30, PIN F2	ALTITUDE 3
	J2	GND	
	K1	GND	
	K2	SLOT 30, PIN H1	ALTITUDE 2
	L1	SLOT 30, PIN H2	ALTITUDE 5
	L2	GND	
	M1	NC	
	M2	SLOT 30, PIN J1	ALTITUDE 4
	N1	GND	
	N2	GND	
	P1	NC	
	P2	SLOT 30, PIN J2	
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 32 C7

FROM		TO	SIGNAL
SLOT	PIN		
32	A1	GND	
	A2	NC	
	B1	SLOT 30 PIN K1	DG/VOR
	B2	NC	
	C1	GND	
	C2	GND	
	D1	SLOT 30, PIN K2	BCD UNITS, 2^1
	D2	SLOT 30, PIN L2	BCD UNITS, 2^0
	E1	SLOT 30, PIN M1	BCD UNITS, 2^3
	E2	SLOT 30, PIN M2	BCD UNITS 2^2
	F1	GND	
	F2	GND	
	H1	SLOT 30, PIN N1	BCD TENS, 2^1
	H2	SLOT 30, PIN N2	BCD TENS, 2^0
	J1	SLOT 30, PIN P2	BCD TENS, 2^3
	J2	GND	
	K1	GND	
	K2	SLOT 30, PIN R1	BCD TENS, 2^2
	L1	SLOT 30, PIN R2	BCD 100's, 2^1
	L2	GND	
	M1	NC	
	M2	SLOT 30, PIN S1	BCD 100's, 2^0
	N1	GND	
	N2	GND	
	P1	NC	
	P2	SLOT 30, PIN S2	LEVEL CLIMB
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 37: C4

FROM		TO	SIGNAL
SLOT	PIN		
37	A1	GND	
	A2	NC	
	B1	SLOT 6 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	B2	NC	
	C1	GND	
	C2	GND	
	D1	SLOT 8 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	D2	SLOT 7 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	E1	SLOT 10 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	E2	SLOT 9 - PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	F1	GND	
	F2	GND	
	H1	SLOT 39 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	H2	SLOT 33 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	J1	SLOT 41 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	J2	GND	
	K1	GND	
	K2	SLOT 40 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	L1	NC	
	L2	GND	
	M1	NC	
	M2	SLOT 42 PINS B1, E1, J1, M1, R1, E2, J2, M2, R2, U2	
	N1	GND	
	N2	GND	
	P1	NC	
	P2	NC	
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 38 M112

FROM SLOT	FROM PIN	TO	SIGNAL
38	A1	SLOT 5, PIN B1	
	A2	+5 VDC	
	B1	SLOT 37, PIN H2	
	B2	NC	
	C1	SLOT 44, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN H2	
	E2	SLOT 37, PIN H2	
	F1	SLOT 44, PIN D1	
	F2	SLOT 44, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN H2	
	J2	SLOT 37, PIN H2	
	K1	SLOT 44, PIN E2	
	K2	SLOT 44, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN H2	
	M2	SLOT 37, PIN H2	
	N1	SLOT 44, PIN F1	
	N2	SLOT 44, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN H2	
	R2	SLOT 37, PIN H2	
	S1	SLOT 44, PIN H2	
	S2	SLOT 44, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN N2	
	V1		
	V2	SLOT 44, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 39:M112

FROM		TO	SIGNAL
SLOT	PIN		
39	A1	SLOT 5, PIN B1	
	A2	+5 VDC	
	B1	SLOT 37, PIN H1	
	B2	NC	
	C1	SLOT 45, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN H1	
	E2	SLOT 37, PIN H1	
	F1	SLOT 45, PIN D1	
	F2	SLOT 45, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN H1	
	J2	SLOT 37, PIN H1	
	K1	SLOT 45, PIN E2	
	K2	SLOT 45, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN H1	
	M2	SLOT 37, PIN H1	
	N1	SLOT 45, PIN F1	
	N2	SLOT 45, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN H1	
	R2	SLOT 37, PIN H1	
	S1	SLOT 45, PIN H2	
	S2	SLOT 45, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN H1	
	V1		
	V2	SLOT 45, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 40:M112

FROM		TO	SIGNAL
SLOT	PIN		
40	A1	SLOT 5, PIN B1	
	A2	+5 VDC	
	B1	SLOT 37, PIN K2	
	B2	NC	
	C1	SLOT 46, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN K2	
	E2	SLOT 37, PIN K2	
	F1	SLOT 46, PIN D1	
	F2	SLOT 46, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN K2	
	J2	SLOT 37, PIN K2	
	K1	SLOT 46, PIN E2	
	K2	SLOT 46, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN K2	
	M2	SLOT 37, PIN K2	
	N1	SLOT 46, PIN F1	
	N2	SLOT 46, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN K2	
	R2	SLOT 37, PIN K2	
	S1	SLOT 46, PIN H2	
	S2	SLOT 46, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN K2	
	V1		
	V2	SLOT 46, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 41:M112

FROM SLOT	FROM PIN	TO	SIGNAL
41	A1	SLOT 5, PIN B1	
	A2	+5 VDC	
	B1	SLOT 37, PIN J1	
	B2	NC	
	C1	SLOT 47, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN J1	
	E2	SLOT 37, PIN J1	
	F1	SLOT 47, PIN D1	
	F2	SLOT 47, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN J1	
	J2	SLOT 37, PIN J1	
	K1	SLOT 47, PIN E2	
	K2	SLOT 47, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN J1	
	M2	SLOT 37, PIN J1	
	N1	SLOT 47, PIN F1	
	N2	SLOT 47, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN J1	
	R2	SLOT 37, PIN J1	
	S1	SLOT 47, PIN H2	
	S2	SLOT 47, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN J1	
	V1		
	V2	SLOT 47, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 42 M112

FROM		TO	SIGNAL
SLOT	PIN		
42	A1	SLOT 5, PIN B1	
	A2	+5 VDC	
	B1	SLOT 37, PIN M2	
	B2	NC	
	C1	SLOT 48, PIN C1	
	C2	GND	
	D1	SLOT 5, PIN D2	
	D2	SLOT 5, PIN H2	
	E1	SLOT 37, PIN M2	
	E2	SLOT 37, PIN M2	
	F1	SLOT 48, PIN D1	
	F2	SLOT 48, PIN J1	
	H1	SLOT 5, PIN D1	
	H2	SLOT 5, PIN H1	
	J1	SLOT 37, PIN M2	
	J2	SLOT 37, PIN M2	
	K1	SLOT 48, PIN E2	
	K2	SLOT 48, PIN K2	
	L1	SLOT 5, PIN E2	
	L2	SLOT 5, PIN K2	
	M1	SLOT 37, PIN M2	
	M2	SLOT 37, PIN M2	
	N1	SLOT 48, PIN F1	
	N2	SLOT 48, PIN L1	
	P1	SLOT 5, PIN E1	
	P2	SLOT 5, PIN J1	
	R1	SLOT 37, PIN M2	
	R2	SLOT 37, PIN M2	
	S1	SLOT 48, PIN H2	
	S2	SLOT 48, PIN M2	
	T1	GND	
	T2	SLOT 5, PIN M2	
	U1		
	U2	SLOT 37, PIN M2	
	V1		
	V2	SLOT 48, PIN N1	

JUNCTION BOX BACKPLANE WIRING

SLOT 44:M111

FROM		TO	SIGNAL
SLOT	PIN		
44	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 38, PIN C1	
	C2	GND	
	D1	SLOT 38, PIN F1	
	D2	SLOT 50, PIN D2	
	E1	SLOT 50, PIN E2	
	E2	SLOT 38, PIN K1	
	F1	SLOT 38, PIN N1	
	F2	SLOT 50, PIN F2	
	H1	SLOT 50, PIN H2	
	H2	SLOT 38, PIN S1	
	J1	SLOT 38, PIN F2	
	J2	SLOT 50, PIN J2	
	K1	SLOT 50, PIN K2	
	K2	SLOT 38, PIN K2	
	L1	SLOT 38, PIN N2	
	L2	SLOT 50, PIN L2	
	M1	SLOT 50, PIN M2	
	M2	SLOT 38, PIN S2	
	N1	SLOT 38, PIN N2	
	N2	SLOT 50, PIN N2	
	P1	SLOT 50, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 45:M111

FROM		TO	SIGNAL
SLOT	PIN		
45	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 39, PIN C1	
	C2	GND	
	D1	SLOT 39, PIN F1	
	D2	SLOT 51, PIN D2	
	E1	SLOT 51, PIN E2	
	E2	SLOT 39, PIN K1	
	F1	SLOT 39, PIN N1	
	F2	SLOT 51, PIN F2	
	H1	SLOT 51, PIN H2	
	H2	SLOT 39, PIN S1	
	J1	SLOT 39, PIN F2	
	J2	SLOT 51, PIN J2	
	K1	SLOT 51, PIN K2	
	K2	SLOT 39, PIN K2	
	L1	SLOT 39, PIN N2	
	L2	SLOT 51, PIN L2	
	M1	SLOT 51, PIN M2	
	M2	SLOT 39, PIN S2	
	N1	SLOT 39, PIN V2	
	N2	SLOT 51, PIN N2	
	P1	SLOT 51, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 46:M111

FROM		TO	SIGNAL
SLOT	PIN		
46	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 40, PIN C1	
	C2	GND	
	D1	SLOT 40, PIN F1	
	D2	SLOT 52, PIN D2	
	E1	SLOT 52, PIN E2	
	E2	SLOT 40, PIN K1	
	F1	SLOT 40, PIN N1	
	F2	SLOT 52, PIN F2	
	H1	SLOT 52, PIN H2	
	H2	SLOT 40, PIN S1	
	J1	SLOT 40, PIN F2	
	J2	SLOT 52, PIN J2	
	K1	SLOT 52, PIN K2	
	K2	SLOT 40, PIN K2	
	L1	SLOT 40, PIN N2	
	L2	SLOT 52, PIN L2	
	M1	SLOT 52, PIN M2	
	M2	SLOT 40, PIN S2	
	N1	SLOT 40, PIN V2	
	N2	SLOT 52, PIN N2	
	P1	SLOT 52, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 47:M111

FROM		TO	SIGNAL
SLOT	PIN		
47	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 41, PIN C1	
	C2	GND	
	D1	SLOT 41, PIN F1	
	D2	SLOT 53, PIN D2	
	E1	SLOT 53, PIN E2	
	E2	SLOT 41, PIN K1	
	F1	SLOT 41, PIN N1	
	F2	SLOT 53, PIN F2	
	H1	SLOT 53, PIN H2	
	H2	SLOT 41, PIN S1	
	J1	SLOT 41, PIN F2	
	J2	SLOT 53, PIN J2	
	K1	SLOT 53, PIN K2	
	K2	SLOT 41, PIN K2	
	L1	SLOT 41, PIN N2	
	L2	SLOT 53, PIN L2	
	M1	SLOT 53, PIN M2	
	M2	SLOT 41, PIN S2	
	N1	SLOT 41, PIN V2	
	N2	SLOT 53, PIN N2	
	P1	SLOT 53, PIN P2	
	P2	NC	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 48:M111

FROM		TO	SIGNAL
SLOT	PIN		
48	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	NC	
	C1	SLOT 42, PIN C1	
	C2	GND	
	D1	SLOT 42, PIN F1	
	D2	SLOT 54, PIN D2	
	E1	SLOT 54, PIN E2	
	E2	SLOT 42, PIN K1	
	F1	SLOT 42, PIN N1	
	F2	SLOT 54, PIN F2	
	H1	SLOT 54, PIN H2	
	H2	SLOT 42, PIN S1	
	J1	SLOT 42, PIN F2	
	J2	SLOT 54, PIN J2	
	K1	SLOT 54, PIN K2	
	K2	SLOT 42, PIN K2	
	L1	SLOT 42, PIN N2	
	L2	SLOT 54, PIN L2	
	M1	SLOT 54, PIN M2	
	M2	SLOT 42, PIN S2	
	N1	SLOT 42, PIN V2	
	N2	SLOT 54, PIN N2	
	P1	SLOT 54, PIN P2	
	P2	NC	
	R1	SLOT 60, PIN L1	SL ADV RGT IN
	R2	NC	
	SI	SLOT 63, PIN D2	SL ADV RGT OUT
	S2	SLOT 60, PIN M2	SK OD IN
	T1	GND	
	T2	SLOT 63, PIN J2	SK OD OUT
	U1	SLOT 64, PIN J2	SK EV OUT
	U2	SLOT 60, PIN P2	SL ADV LFT IN
	V1	SLOT 60, PIN J1	SK EV IN
	V2	SLOT 64, PIN D2	SL ADV LFT OUT

JUNCTION BOX BACKPLANE WIRING

SLOT 50: M050

FROM		TO	SIGNAL
SLOT	PIN		
50	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	- 15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 25, PIN J2	
	D2	SLOT 44, PIN D2	
	E1	SLOT 25, PIN K1	
	E2	SLOT 44, PIN E1	
	F1	SLOT 25, PIN K2	
	F2	SLOT 44, PIN F2	
	H1	SLOT 25, PIN L1	
	H2	SLOT 44, PIN H1	
	J1	SLOT 25, PIN L2	
	J2	SLOT 44, PIN J2	
	K1	SLOT 25, PIN M1	
	K2	SLOT 44, PIN K1	
	L1	SLOT 25, PIN M2	
	L2	SLOT 44, PIN L2	
	M1	SLOT 25, PIN N1	
	M2	SLOT 44, PIN M1	
	N1	SLOT 25, PIN N2	
	N2	SLOT 44, PIN N2	
	P1	SLOT 25, PIN P1	
	P2	SLOT 44, PIN P1	
	R1	NC	
	R2	NC	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 51:M050

FROM		TO	SIGNAL
SLOT	PIN		
51	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	- 15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 25, PIN P2	
	D2	SLOT 45, PIN D2	
	E1	SLOT 25, PIN R1	
	E2	SLOT 45, PIN E1	
	F1	SLOT 25, PIN R2	
	F2	SLOT 45, PIN F2	
	H1	SLOT 25, PIN S1	
	H2	SLOT 45, PIN H1	
	J1	SLOT 25, PIN S2	
	J2	SLOT 45, PIN J2	
	K1	SLOT 25, PIN T2	
	K2	SLOT 45, PIN K1	
	L1	SLOT 25, PIN U1	
	L2	SLOT 45, PIN L2	
	M1	SLOT 25, PIN U2	
	M2	SLOT 45, PIN M1	
	N1	SLOT 25, PIN V1	
	N2	SLOT 45, PIN N2	
	P1	SLOT 25, PIN V2	
	P2	SLOT 45, PIN P1	
	R1	SLOT 56, PIN V1	
	R2	SLOT 60, PIN B1	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 52:M050

FROM		TO	SIGNAL
SLOT	PIN		
52	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	-15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 56, PIN A1	
	D2	SLOT 46, PIN D2	
	E1	SLOT 56, PIN B1	
	E2	SLOT 46, PIN E1	
	F1	SLOT 56, PIN C1	
	F2	SLOT 46, PIN F2	
	H1	SLOT 46, PIN D1	
	H2	SLOT 46, PIN H1	
	J1	SLOT 56, PIN D2	
	J2	SLOT 46, PIN J2	
	K1	SLOT 56, PIN E1	
	K2	SLOT 46, PIN K1	
	L1	SLOT 56, PIN E2	
	L2	SLOT 46, PIN L2	
	M1	SLOT 56, PIN F1	
	M2	SLOT 46, PIN M1	
	N1	SLOT 56, PIN F2	
	N2	SLOT 46, PIN N2	
	P1	SLOT 56, PIN H1	
	P2	SLOT 46, PIN P1	
	R1	SLOT 56, PIN R2	
	R2	SLOT 59, PIN B1	
	S1	SLOT 56, PIN S1	
	S2	SLOT 59, PIN D2	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 53:M050

FROM		TO	SIGNAL
SLOT	PIN		
53	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	-15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 56, PIN H2	
	D2	SLOT 47, PIN D2	
	E1	SLOT 56, PIN J1	
	E2	SLOT 47, PIN E1	
	F1	SLOT 56, PIN J2	
	F2	SLOT 47, PIN F2	
	H1	SLOT 56, PIN K1	
	H2	SLOT 47, PIN H1	
	J1	SLOT 56, PIN K2	
	J2	SLOT 47, PIN J2	
	K1	SLOT 56, PIN L1	
	K2	SLOT 47, PIN K1	
	L1	SLOT 56, PIN L2	
	L2	SLOT 47, PIN L2	
	M1	SLOT 56, PIN M1	
	M2	SLOT 47, PIN M1	
	N1	SLOT 56, PIN M2	
	N2	SLOT 47, PIN N2	
	P1	SLOT 56, PIN N1	
	P2	SLOT 47, PIN P1	
	R1	SLOT 56, PIN S2	
	R2	SLOT 59, PIN D1	
	S1	SLOT 56, PIN T2	
	S2	SLOT 59, PIN E2	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 54: M050

FROM		TO	SIGNAL
SLOT	PIN		
54	A1	NC	
	A2	+5 VDC	
	B1	NC	
	B2	-15 VDC	
	C1	NC	
	C2	GND	
	D1	SLOT 56, PIN N2	
	D2	SLOT 48, PIN D2	
	E1	SLOT 56, PIN P1	
	E2	SLOT 48, PIN E1	
	F1	SLOT 56, PIN P2	
	F2	SLOT 48, PIN F2	
	H1	SLOT 56, PIN R1	
	H2	SLOT 48, PIN H1	
	J1	NC	
	J2	SLOT 48, PIN J2	
	K1	NC	
	K2	SLOT 48, PIN K1	
	L1	NC	
	L2	SLOT 48, PIN L2	
	M1	NC	
	M2	SLOT 48, PIN M1	
	N1	NC	
	N2	SLOT 48, PIN N2	
	P1	NC	
	P2	SLOT 48, PIN P1	
	R1	SLOT 56, PIN U1	
	R2	SLOT 59, PIN E1	
	S1	SLOT 56, PIN U2	
	S2	SLOT 59, PIN H2	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	NC	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 56

FROM		TO	SIGNAL
SLOT	PIN		
56	A1	SLOT 52, PIN D1	
	A2	NC	
	B1	SLOT 52, PIN E1	
	B2	NC	
	C1	SLOT 52, PIN F1	
	C2	GND	
	D1	SLOT 52, PIN H1	
	D2	SLOT 52, PIN J1	
	E1	SLOT 52, PIN K1	
	E2	SLOT 52, PIN L1	
	F1	SLOT 52, PIN M1	
	F2	SLOT 52, PIN N1	
	H1	SLOT 52, PIN P1	
	H2	SLOT 53, PIN D1	
	J1	SLOT 53, PIN E1	
	J2	SLOT 53, PIN F1	
	K1	SLOT 53, PIN H1	
	K2	SLOT 53, PIN J1	
	L1	SLOT 53, PIN K1	
	L2	SLOT 53, PIN L1	
	M1	SLOT 53, PIN M1	
	M2	SLOT 53, PIN N1	
	N1	SLOT 53, PIN P1	
	N2	SLOT 54, PIN D1	
	P1	SLOT 54, PIN E1	
	P2	SLOT 54, PIN F1	
	R1	SLOT 54, PIN H1	
	R2	SLOT 52, PIN R1	
	S1	SLOT 52, PIN S1	
	S2	SLOT 53, PIN R1	
	T1	GND	
	T2	SLOT 53, PIN S1	
	U1	SLOT 54, PIN R1	
	U2	SLOT 54, PIN S1	
	V1	SLOT 51, PIN R1	
	V2	GND	

JUNCTION BOX BACKPLANE WIRING

SLOT 59:C8

FROM SLOT	FROM PIN	TO	SIGNAL
59	A1	GND	
	A2	NC	
	B1	SLOT 52, PIN R2	
	B2	NC	
	C1	GND	
	C2	GND	
	D1	SLOT 53, PIN R2	
	D2	SLOT 52, PIN S2	
	E1	SLOT 54, PIN R2	
	E2	SLOT 53, PIN S2	
	F1	GND	
	F2	GND	
	H1	NC DO NOT GND	
	H2	SLOT 54 PIN S2	
	J1	NC DO NOT GND	
	J2	GND	
	K1	GND	
	K2	NC DO NOT GND	
	L1	NC DO NOT GND	
	L2	GND	
	M1	NC	
	M2	NC DO NOT GND	
	N1	GND	
	N2	GND	
	P1	NC	
	P2	NC DO NOT GND	
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
↓	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 60:C8

FROM		TO	SIGNAL
SLOT	PIN		
60	A1	GND	
	A2	NC	
	B1	SLOT 51, PIN R2	
	B2	NC	
	C1	GND	
	C2	GND	
	D1	NC	
	D2	NC	
	E1	NC	
	E2	NC	
	F1	GND	
	F2	GND	
	H1	NC	
	H2	NC	
	J1	SLOT 48, PIN V1	SK EV
	J2	GND	
	K1	GND	
	K2	NC	
	L1	SLOT 48, PIN R1	SL ADV RGT
	L2	GND	
	M1	NC	
	M2	SLOT 48, PIN S2	SK OD
	N1	GND	
	N2	GND	
	P1	NC	
	P2	SLOT 48, PIN U2	SL ADV LFT
	R1	GND	
	R2	GND	
	S1	NC	
	S2	NC	
	T1	GND	
	T2	NC	
	U1	NC	
	U2	GND	
	V1	NC	
	V2	NC	

JUNCTION BOX BACKPLANE WIRING

SLOT 61: RELAY BOARD

FROM		TO	SIGNAL
SLOT	PIN		
61	A1		
	A2	+5 VDC	
	B1		
	B2	SLOT 61, PIN K2	+15 VDC
	C1		
	C2	GND	
	D1		
	D2	SLOT 30, PIN T2 & SLOT 61, PIN L2	SL ADV LFT - OUT, COMMON
	E1		
	E2	SLOT 30, PIN U1	SL ADV LFT - OUT, NO
	F1		
	F2	NC	NC, NOT USED
	H1		
	H2	SLOT 64, PIN R2	SL ADV LFT - INPUT
	J1		
	J2	SLOT 63, PIN R2	SL ADV RGT - INPUT
	K1		
	K2	SLOT 61, PIN B2 & SLOT 62, PIN B2	+15VDC
	L1		
	L2	SLOT 61, PIN D2 & SLOT 62, PIN D2	SL ADV RGT - OUT, COMMON
	M1		
	M2	SLOT 30, PIN V1	SL ADV RGT - OUT, NO
	N1		
	N2	NC	NC, NOT USED
	P1		
	P2		
	R1		
	R2		
	S1		
	S2		
	T1	GND	
	T2		
	U1		
	U2		
	V1		
	V2		

JUNCTION BOX BACKPLANE WIRING

SLOT 62:RELAY BOARD

FROM		TO	SIGNAL
SLOT	PIN		
62	A1		
	A2	+5 VDC	
	B1		
	B2	SLOT 61, PIN K2 & SLOT 62, PIN K2	+15 VDC
	C1		
	C2	GND	
	D1		
	D2	SLOT 61, PIN L2 & SLOT 62, PIN L2	SK EVEN · OUT, COMMON
	E1		
	E2	SLOT 30, PIN U2	SK EVEN · OUT, NO
	F1		
	F2	NC	NC, NOT USED
	H1		
	H2	SLOT 64, PIN S2	SK EVEN · INPUT
	J1		
	J2	SLOT 63, PIN S2	SK ODD · INPUT
	K1		
	K2	SLOT 62, PIN B2 & SLOT 64, PIN V2	+15 VDC
	L1		
	L2	SLOT 62, PIN D2	SK ODD · OUT, COMMON
	M1		
	M2	SLOT 30, PIN P1	SK ODD · OUT, NO
	N1		
	N2	NC	NC, NOT USED
	P1		
	P2		
	R1		
	R2		
	S1		
	S2		
	T1	GND	
	T2		
	U1		
	U2		
	V1		
	V2		

JUNCTION BOX BACKPLANE WIRING

SLOT 63:M040

FROM		TO	SIGNAL
SLOT	PIN		
63	A1		
	A2	+5 VDC	
	B1		
	B2	-15 VDC	
	C1		
	C2	GND	POS TERM OF RELAY SUPPLY
	D1		
	D2	SLOT 48, PIN S1	SK ADV RGT IN
	E1		
	E2	SLOT 42, PIN V1	
	F1		
	F2	SLOT 42, PIN V1	
	H1		
	H2	SLOT 42, PIN V1	
	J1		
	J2	SLOT 48, PIN T2	SK OD IN
	K1		
	K2	SLOT 42, PIN U1	
	L1		
	L2	SLOT 42, PIN U1	
	M1		
	M2	SLOT 42, PIN U1	
	N1		
	N2	NC	
	P1		
	P2	NC	
	R1		
	R2	SLOT 61, PIN J2	SK ADV RGT OUT
	S1		
	S2	SLOT 62, PIN J2	SK OD OUT
	T1	GND	
	T2	NC	
	U1		
	U2	NC	
	V1		
	V2	SLOT 64, PIN V2	+15 VDC

JUNCTION BOX BACKPLANE WIRING

SLOT 64 M040

FROM		TO	SIGNAL
SLOT	PIN		
64	A1		
	A2	+5 VDC	
	B1		
	B2	- 15 VDC	
	C1		
	C2	GND	POS TERM OF RELAY SUPPLY
	D1		
	D2	SLOT 48, PIN V2	SL ADV LFT IN
	E1		
	E2	SLOT 41, PIN V1 & SLOT 64, PIN K2	
	F1		
	F2	SLOT 41, PIN V1 & SLOT 64, PIN L2	
	H1		
	H2	SLOT 41, PIN V1 & SLOT 64, PIN M2	
	J1		
	J2	SLOT 48, PIN U1	SK EV IN
	K1		
	K2	SLOT 64, PIN E2	
	L1		
	L2	SLOT 64, PIN F2	
	M1		
	M2	SLOT 64, PIN H2	
	N1		
	N2	NC	
	P1		
	P2	NC	
	R1		
	R2	SLOT 61, PIN H2	SL ADV LFT OUT
	S1		
	S2	SLOT 62, PIN H2	SK EV OUT
	T1	GND	
	T2	NC	
	U1		
	U2	NC	
	V1		
	V2	SLOT 63, PIN V2 & SLOT 62, PIN K2	+15 VDC

SUPERVISOR'S CONSOLE

I. INTRODUCTION

The Supervisor's Console is a multifunctional unit which was designed for two main purposes. First, the front console contains the input/output controls and reference displays necessary for running an experiment. Secondly, the unit houses equipments necessary for the VDS system which are external to the GAT–1 and computer. Because of these aspects, the Supervisor's Console serves as a routing station for signals to and from the projection, GAT–1, and computer subsystems.

Housed within the console are the Navigational Area Programming Panels for the GAT–1 and the Junction Box with the 5VDC and 15VDC power supplies for the digital I/O signals. Detailed information concerning these components can be found in Section VII, Junction Box, and Section IX, Navigational Area Programming Panels. Information concerning the front panel controls and the routing of signals within the console are presented in this section.

II. PANEL DESCRIPTION

The panel layout is pictorially represented in Figure 8-1. A brief description of the instruments and controls on the panel is as follows:

A. CLOCK

A digital clock is provided for timing experimental sessions. The time clock can be manually controlled by either the controls on the clock itself or by the START, STOP, and CONTINUE pushbuttons on the Supervisor's Console. The START button resets the clock to a zero reading, the CONTINUE button starts the clock timing, and the STOP button halts timing. At present, the clock cannot be controlled by the computer. The clock is enabled when the power switch at the console is turned on.

B. POWER SWITCH AND LIGHT INDICATOR

The power switch enables the digital clock, and the 5VDC, and the 15VDC power supply for the Junction Box. This switch can only be activated when the computer is on. When these power sources are enabled, the red indicator light above the switch will be lit. The toggle switch should be placed in an upward position for ON.

C. RESPONSE SWITCH AND LIGHT INDICATOR

The response switch is not presently connected. However, if the POWER switch at the console is ON, the green indicator light will be lit when the response button in the GAT–1 is pressed.

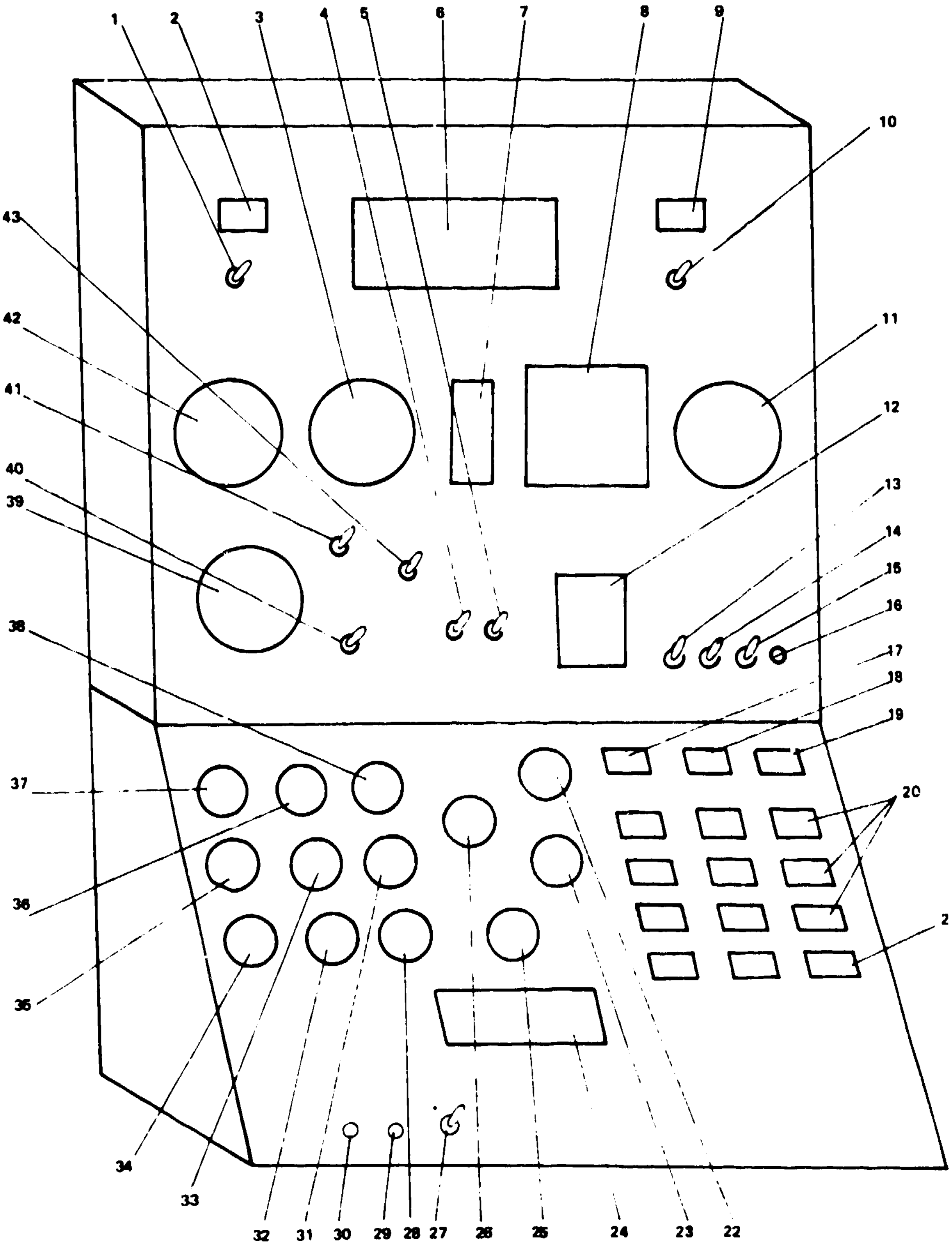


Figure 8-1. Supervisc 's Console

Table 8-1

SUPERVISOR'S CONSOLE DESCRIPTION GUIDE

Index No.	Part
1	Junction Box Power Switch
2	Indicator Light
3	Airspeed Repeater Gauge
4	Projector Forward/Reverse Toggle Switch
5	Projection Booth Power Switch
6	Clock
7	Rate of Climb Repeater Gauge
8	Directional Gyro Repeater Gauge
9	Indicator Light
10	Response Toggle Switch
11	VOR-ILS Deviation Repeater Gauge
12	Heading Selection Thumbwheel Switches
13	DG/VOR Selection Toggle Switch
14	VOR ON/OFF Toggle Switch
15	Compute/Suspend Toggle Switch
16	Indicator Light
17	Computer/Clock Start Pushbutton Switch
18	Computer/Clock Stop Pushbutton Switch
19	Computer/Clock Continue Pushbutton Switch
20	Detect Sector Pushbutton Switches
21	Detect Error Pushbutton Switch
22	Wind Velocity Potentiometer
23	Field Elevation Potentiometer
24	VHF Communication Frequency Readout Meters
25	Center of Gravity Potentiometer
26	Wind Direction Potentiometer
27	Press To Talk Switch
28	Gross Weight Potentiometer
29	Microphone Jack
30	Headset Jack
31	Engine Sound Potentiometer
32	Barometric Pressure Potentiometer
33	Outside Air Temperature Potentiometer
34	Rought Air Potentiometer
35	Right & Left Tank Fuel Potentiometers
36	Oil Temperature Potentiometer
37	Oil Pressure Potentiometer
38	Cylinder Head Temperature Potentiometer
39	Altitude Reference Rotary Switch
40	IFR/VFR Reference Toggle Switch
41	Level/Climb Reference Toggle Switch
42	Altitude Repeater Gauge
43	Airspeed Reference Toggle Switch

D. FLIGHT REPEATER GAUGES

There are five repeater aircraft instruments to monitor a pilot's flight performance. These indicators include Altitude, Airspeed, Rate of Climb, Heading, and VOR–ILS Deviation. All gauges except the VOR–ILS Deviation instrument will be activated when the GAT–1 is turned on. The VOR–ILS gauge is operational only when a VOR or ILS station is tuned in on the Mark–12 panel in the GAT–1 cockpit and when the VOR ON/OFF switch at the console is ON.

E. PROJECTOR CONTROLS

The ON/OFF toggle switch controls the 120 VAC power to the outlets in the projection booth. Since all projectors or dissolve units are plugged into these outlets, the switch enables the projection system. The toggle switch should be placed in an upward position for ON.

The FORWARD/REVERSE toggle switch is not connected. A remote control box provides for manual control of the projectors. This box is linked to the connector plug located on the back of the console above the Navigational Programming Panels.

F. DIGITAL INPUT CONTROLS TO PDP 8/e

1. The following controls serve to provide reference values for assessing flight performance.

a. Altitude and Altitude Rate

The LEVEL/CLIMB toggle switch determines whether the altitude analog signal is compared to the altitude reference switches or to a rate of descent/climb of 500 ft./min. The altitude rotary switch is used to set the altitude reference value. Since the altitude references can have two values, the IFR/VFR toggle switch determines which has been selected. The altitude values that can be selected are presented below.

IFR	0	2000	3000	4000	5000
VFR	0	1000	2500	3500	4500

The LEVEL/CLIMB switch should be placed in an upward position (LEVEL) to base figure-of-merit comparison to a specified altitude set on the altitude rotary switch. The IFR/VFR toggle switch should be in an upward position (IFR) if the maximum or upper value is desired and in the downward position (VFR) for the lower value.

When the analog signal is to be compared to a ± 500 ft./min. change, the LEVEL/CLIMB switch should be placed in a downward position (CLIMB). If the comparison is for an ascent, the altitude reference switch should be set on an altitude lower than the true altitude of the aircraft. For a descent, the altitude reference should be set at an altitude greater than the true altitude of the aircraft. During an experimental run, caution should be employed to insure that the aircraft is always below the altitude reference for a descent or above the altitude reference for climbing. Otherwise, the performance calculations will be in error.

b. Airspeed

A two position toggle switch has been provided for selecting two different airspeeds, 95 MPH or 115 MPH, as reference values. Under cruise conditions, the 115 MPH should be used as the reference, while 95 MPH should be used for climbing or descending. The toggle switch should be placed in an upward position for 115 MPH and a downward position for 95 MPH.

c. Heading and VOR/ILS Deviation

The DG/VOR toggle switch determines whether the heading sine/cosine analog signals or the VOR/ILS course deviation analog signals are to be used as the performance measure for calculation. The toggle switch should be placed in an upward position (DG) for heading calculations and in downward position (VOR) for VOR/ILS course deviation calculations. When heading calculations are to be made the heading reference values should be selected on the HEADING SELECT thumbwheel switches. The reference value for VOR/ILS course deviation is automatically set for zero in the computer program.

d. Compute or Suspend and Light Indicator

The COMPUTE/SUSPEND toggle switch determines whether the samples of the analog signals will be included in the data analysis. When the toggle switch is in the upward position (COMPUTE), all analog samples are compared to their reference values and the results are combined with calculations of previous samples. When the switch is placed in the downward position (SUSPEND), calculations of the analog samples are not made and the signal input is ignored. The purpose for this switch is to suspend calculations of the data when reference values are changed and when a pilot is required to maneuver his aircraft for a flight scenario which corresponds to the

reference values. During an experimental run, caution should be employed to insure that this switch is placed in the SUSPEND position at the appropriate times. Otherwise the performance calculation will be in error. The light indicator is on when the toggle switch is in the SUSPEND position.

2. Pushbutton switches for detection inputs and computer controls.

   a. The DETECT SECTOR switches 1 through 14 are used by the supervisor to indicate which screen sector the subject verbally reports having detected a target. This information is utilized by the computer program to determine whether the detection is valid Several seconds must elapse between successive inputs via these switches.

   b. The DETECT ERROR switch is activated by the experimenter to indicate that the subject inadvertently pressed the response button in the GAT–1 and was not attempting to report a target detection. These data are included in the data output.

   c. The START, STOP, and CONTINUE buttons control the computer run of an experiment and the digital clock. START initiates a program run, STOP halts an experimental run, and CONTINUE resumes an experimental run after a STOP. The digital clock controls have been explained above in Section X, Part A, Clock.

G. INPUTS TO GAT–1

1. OIL PRESSURE, OIL TEMPERATURE, and CYLINDER HEAD TEMPERATURE controls determine the gauge readings of the corresponding instruments in the trainer. These inputs are not used in the analog computations of the flight conditions. Under standard conditions, these should be set so the indicators in the GAT–1 are in the green regions.

2. The RIGHT and LEFT TANK controls are the same type as above. The middle knob regulates the left fuel tank gauge, while the outer dial regulates the right fuel tank guage.

3. OUTSIDE AIR TEMPERATURE, GROSS WEIGHT, and CENTER OF GRAVITY controls regulate inputs that are used in the analog computations. For normal conditions, CENTER OF GRAVITY should be set to 25%, GROSS WEIGHT to 1600 lbs., and OUTSIDE AIR TEMPERATURE to STD. The control positions for these conditions are marked on the panel.

4. ENGINE SOUND control regulates the volume of the sound output from the loudspeaker in the cockpit.

5. ROUGH AIR control regulates the amplitude of the rough air signal which is applied as an input to the motion system and the airspeed indicator.

6. BAROMETRIC PRESSURE control allows for changing the barometric pressure between the limits of 29.00 and 31.00 inches of mercury. The calibration table in Section VI, VDS Analog Signals, Part III, gives the control settings for specified barometric pressure levels. This is a VDS Analog Signal which is used in the calculations of the altitude performance measurement. Therefore, if a pilot is instructed to change the barometric pressure on his altimeter, a corresponding change must be made on the Supervisor's Console.

7. WIND VELOCITY and WIND FROM controls regulate the simulated speed and direction of the wind. Both of these controls are calibrated VDS Analog Signals. Refer to calibration table in Section VI, VDS Analog Signals, Part III for the dial setting of the VELOCITY control for specific wind speed.

8. FIELD ELEVATION control regulates the elevation of simulated airports. This is a VDS Analog Signal. The calibration table in Section VI, VDS Analog Signals, Part III gives the specific control settings for specific elevations.

9. The VHF COMMUNICATION FREQUENCY readout consists of three current operated meters which display the frequency in MHz to which the VHF NAV/COMM receiver in the cockpit is tuned.

10. Communication jacks located at the lower left hand side of the panel for a microphone and headset allow for communication with a pilot during flight. For an experimenter to transmit a message, the press to talk toggle switch must be placed in the downward position.

III. WIRING DIAGRAM

Figure 8-2 functionally illustrates the routing of the signals to and from the Supervisor's Console. Figures 8-3 through 8-9 depict the specific wiring schematics for the controls and instruments on the console.

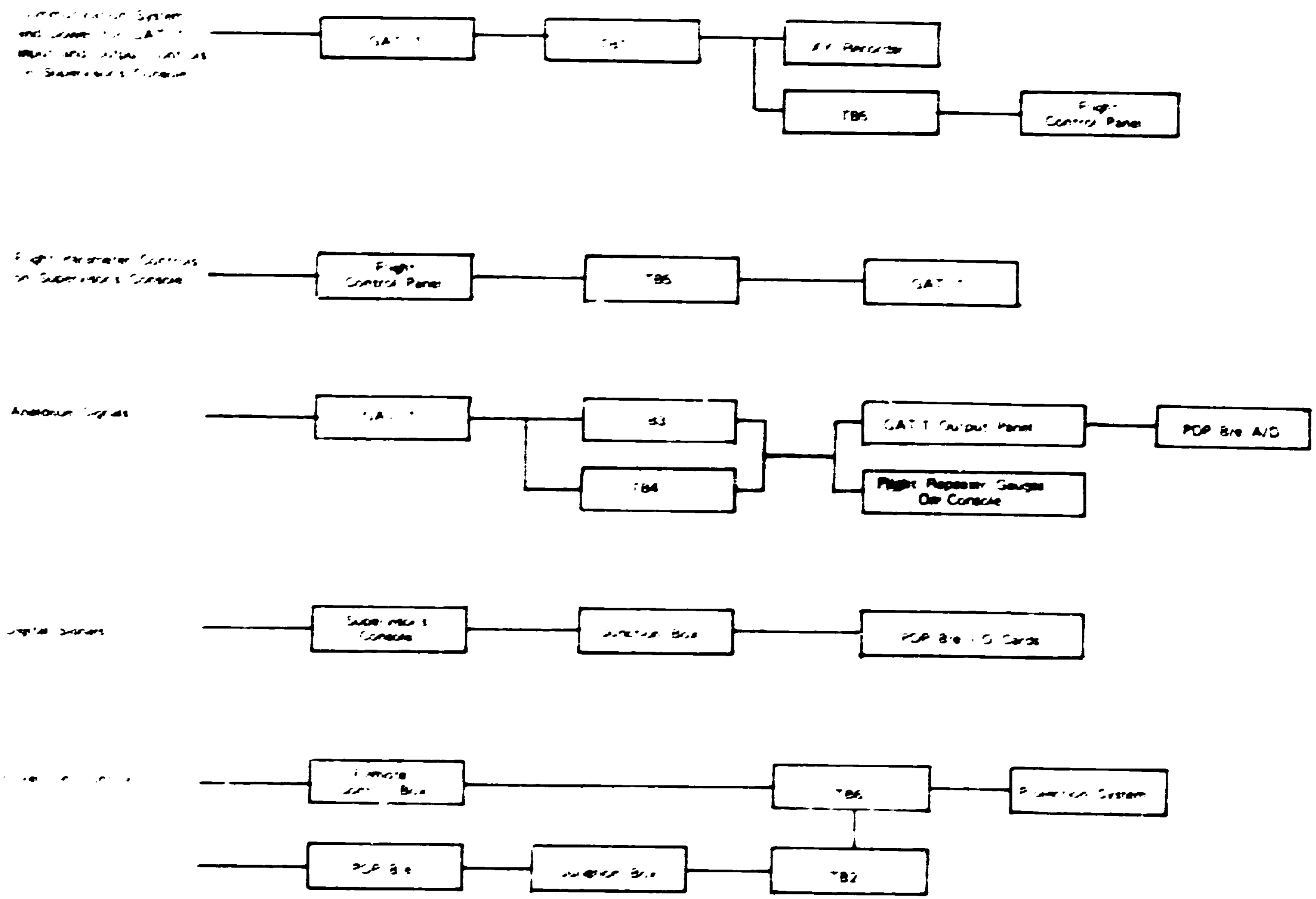


Figure 8-2 Signal Routing in Supervisor's Console

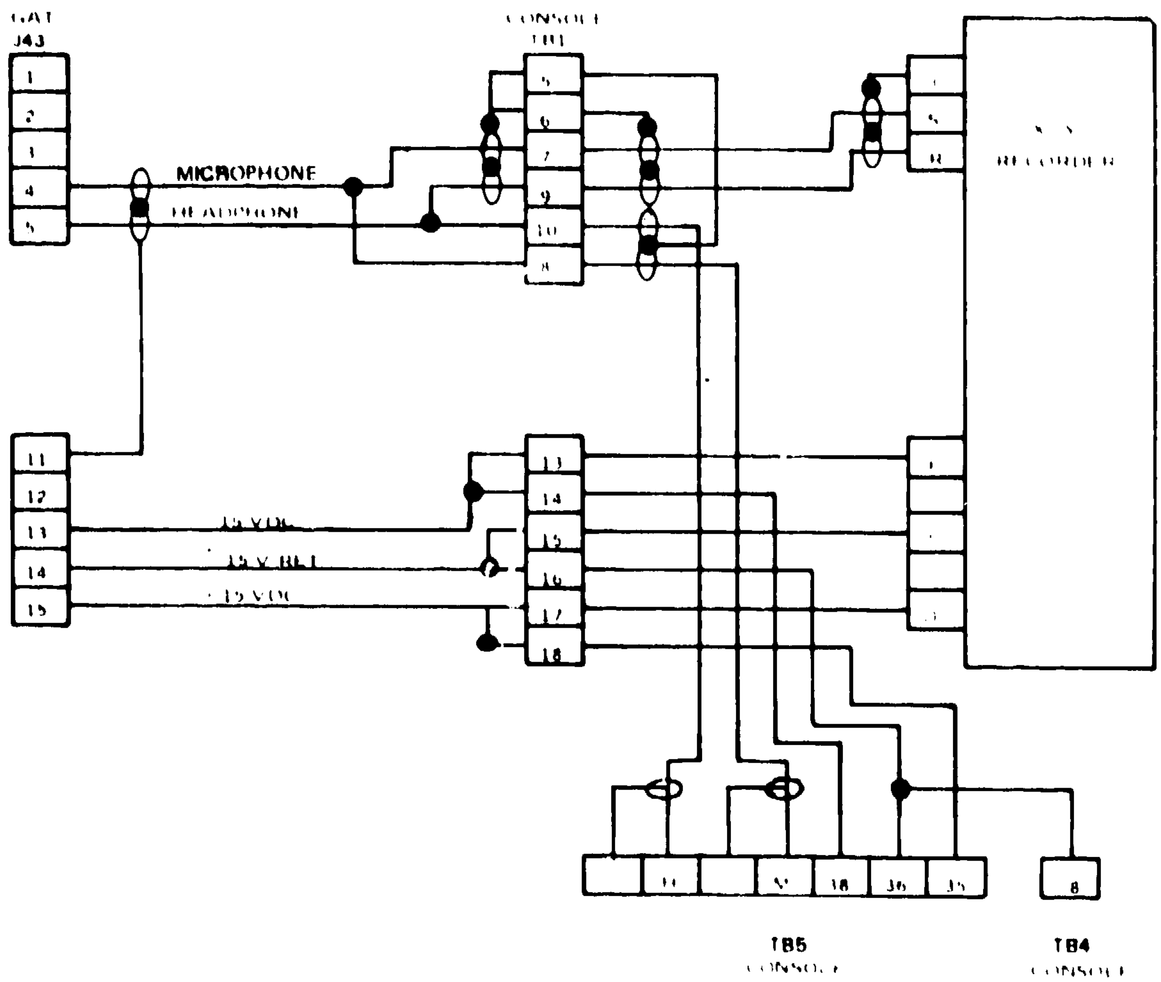


Figure 8-3. Slip Ring Wiring Schematic

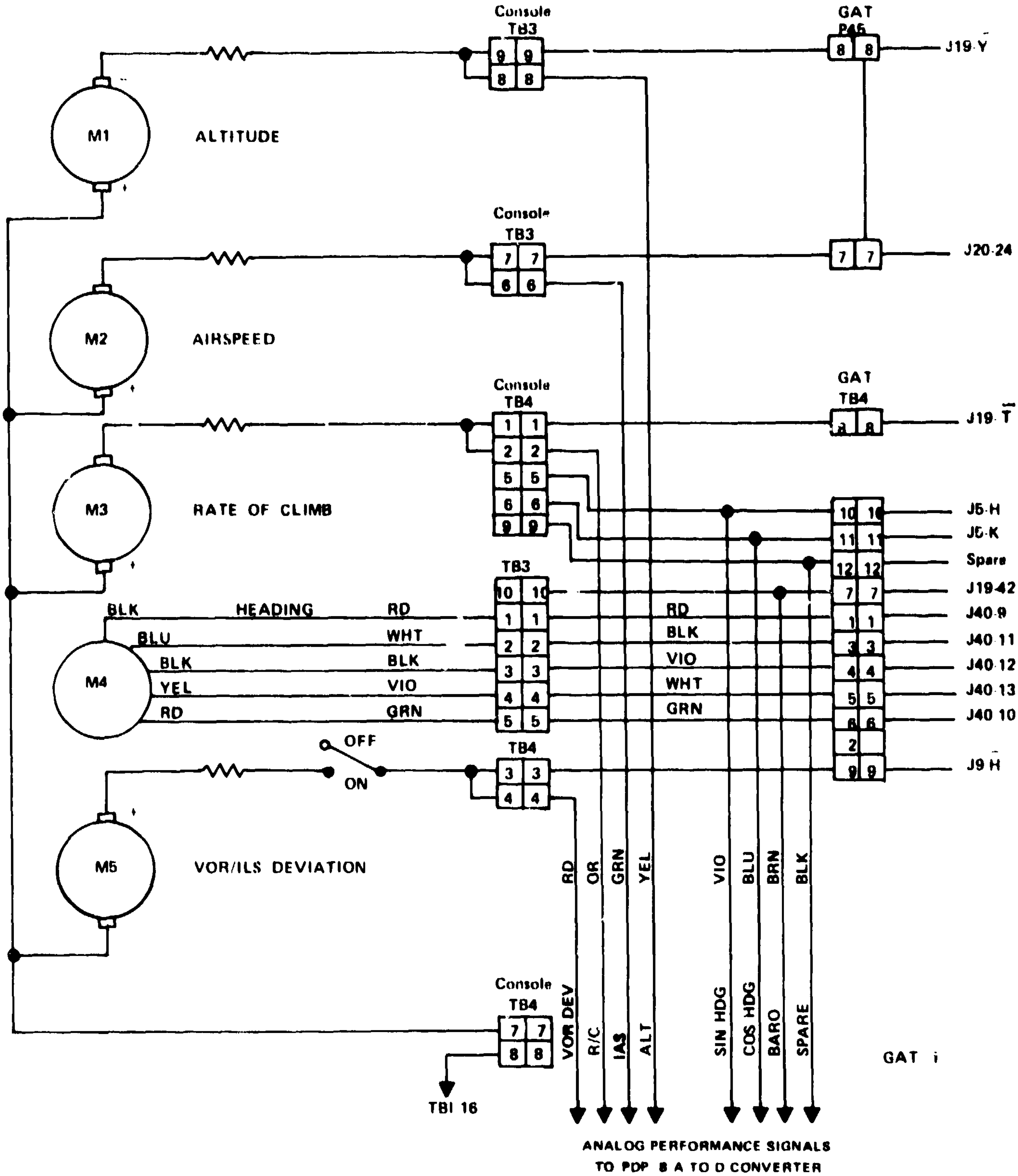


Figure 8-4. Aircraft Performance Indicators Wiring Schematic

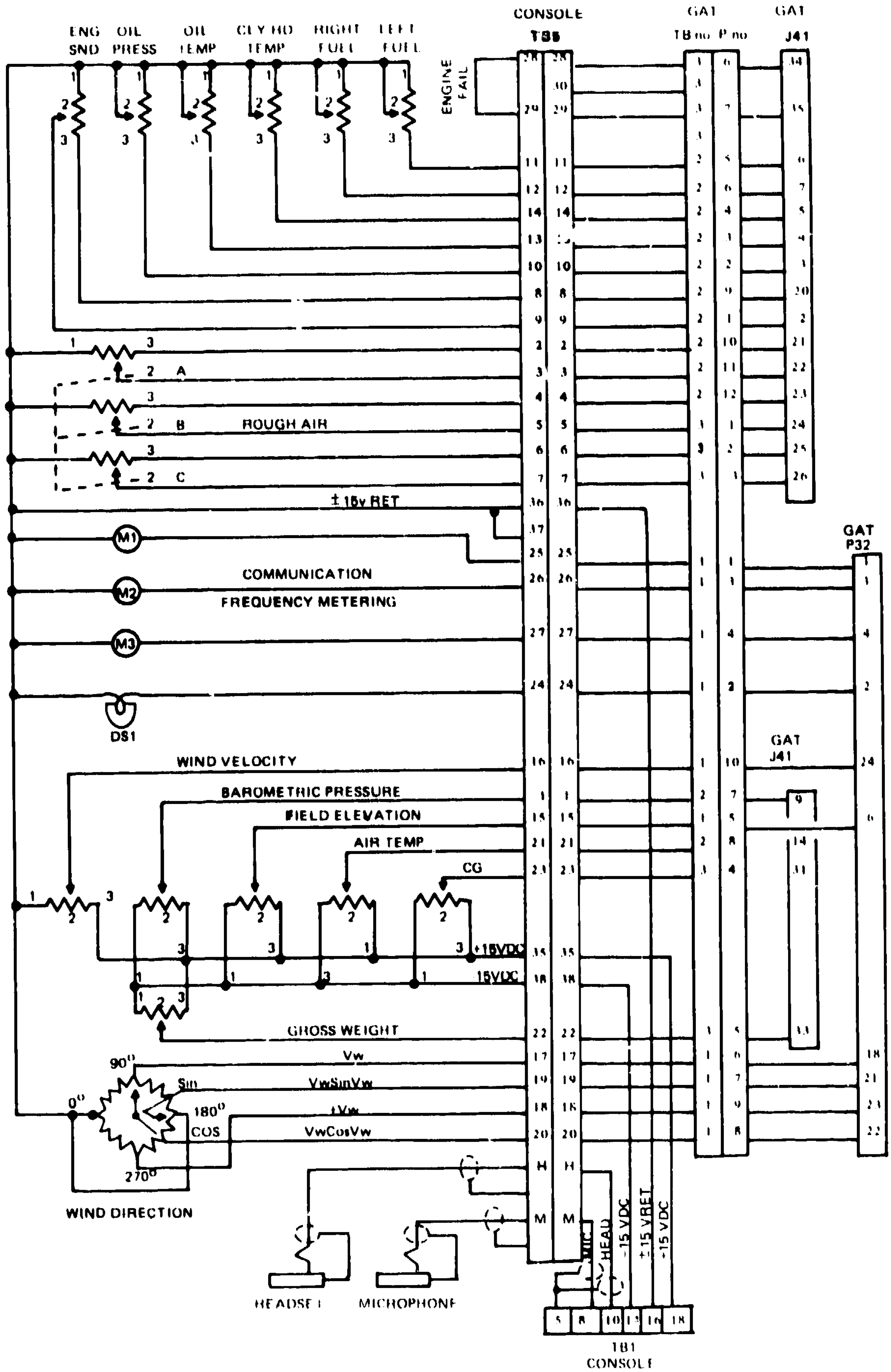


Figure 8-5. Flight Parameter Controls Wiring Schematic

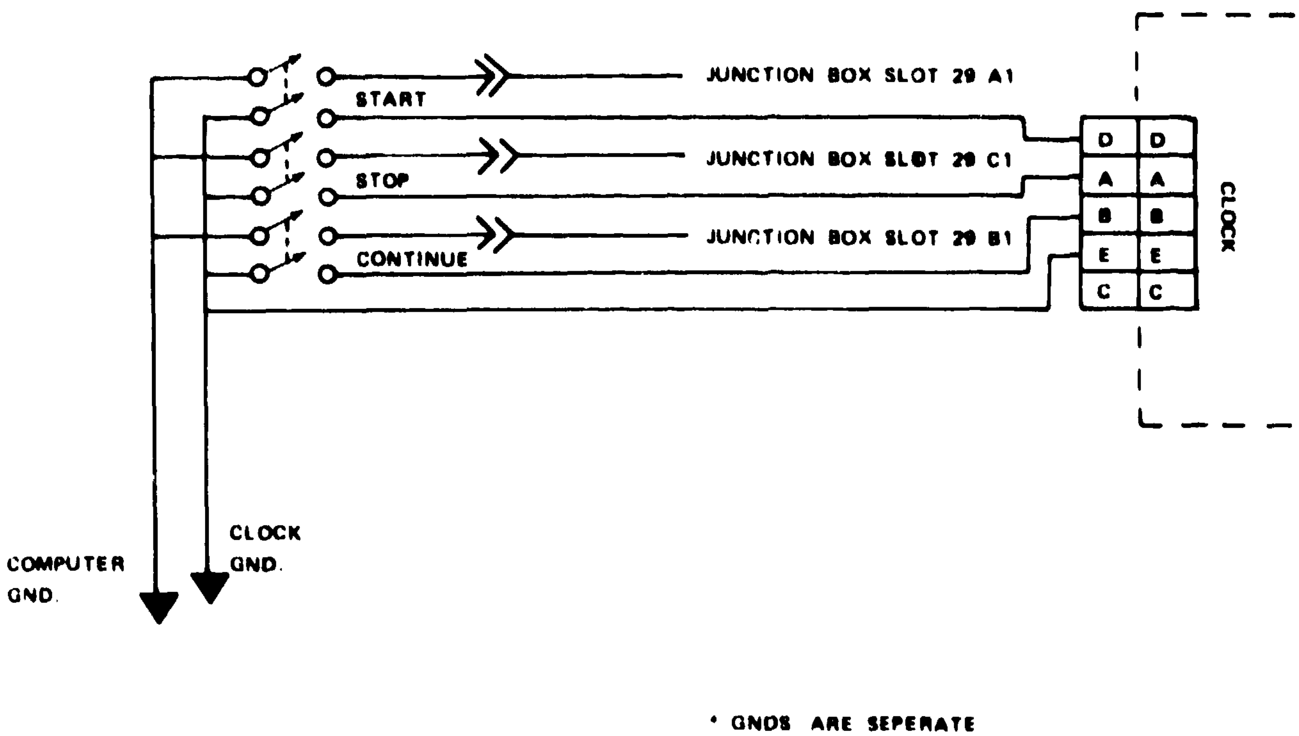


Figure 8-6. Clock Control System Wiring Schematic

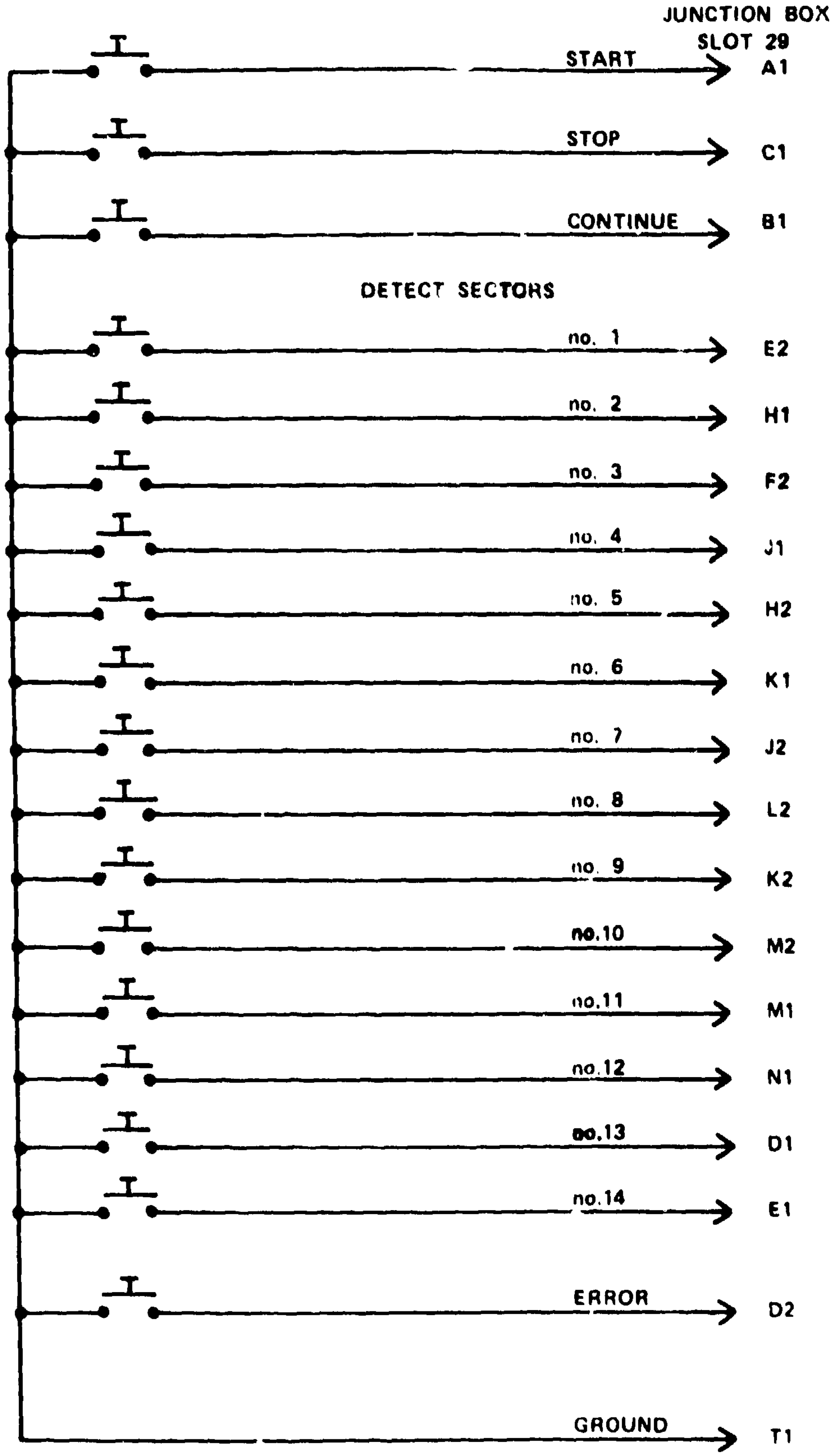


Figure 8-7. Computer Control and Detect Sector Push Buttons Wiring Schematic

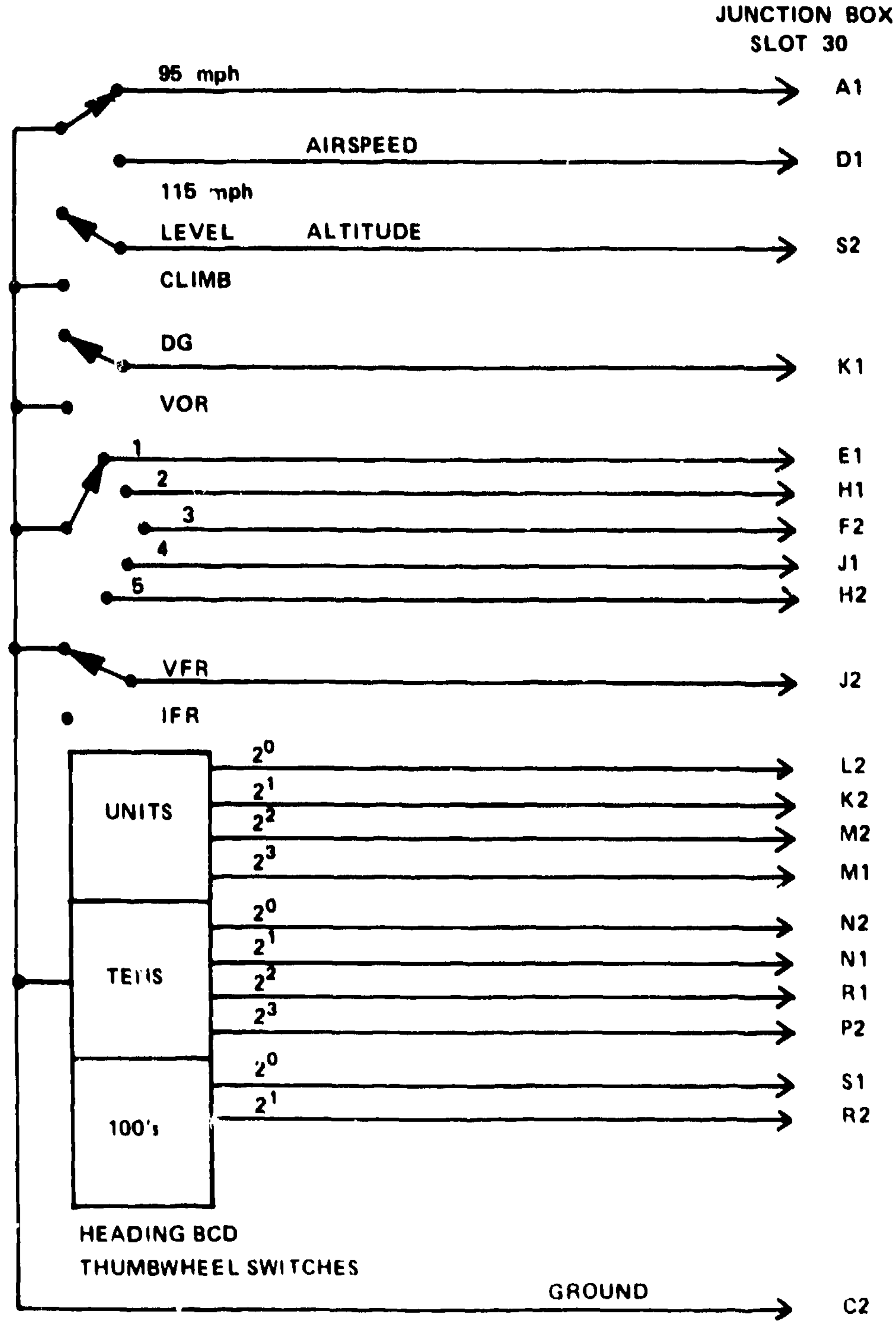


Figure 8-8. Command Parameter Switches Wiring Schematic

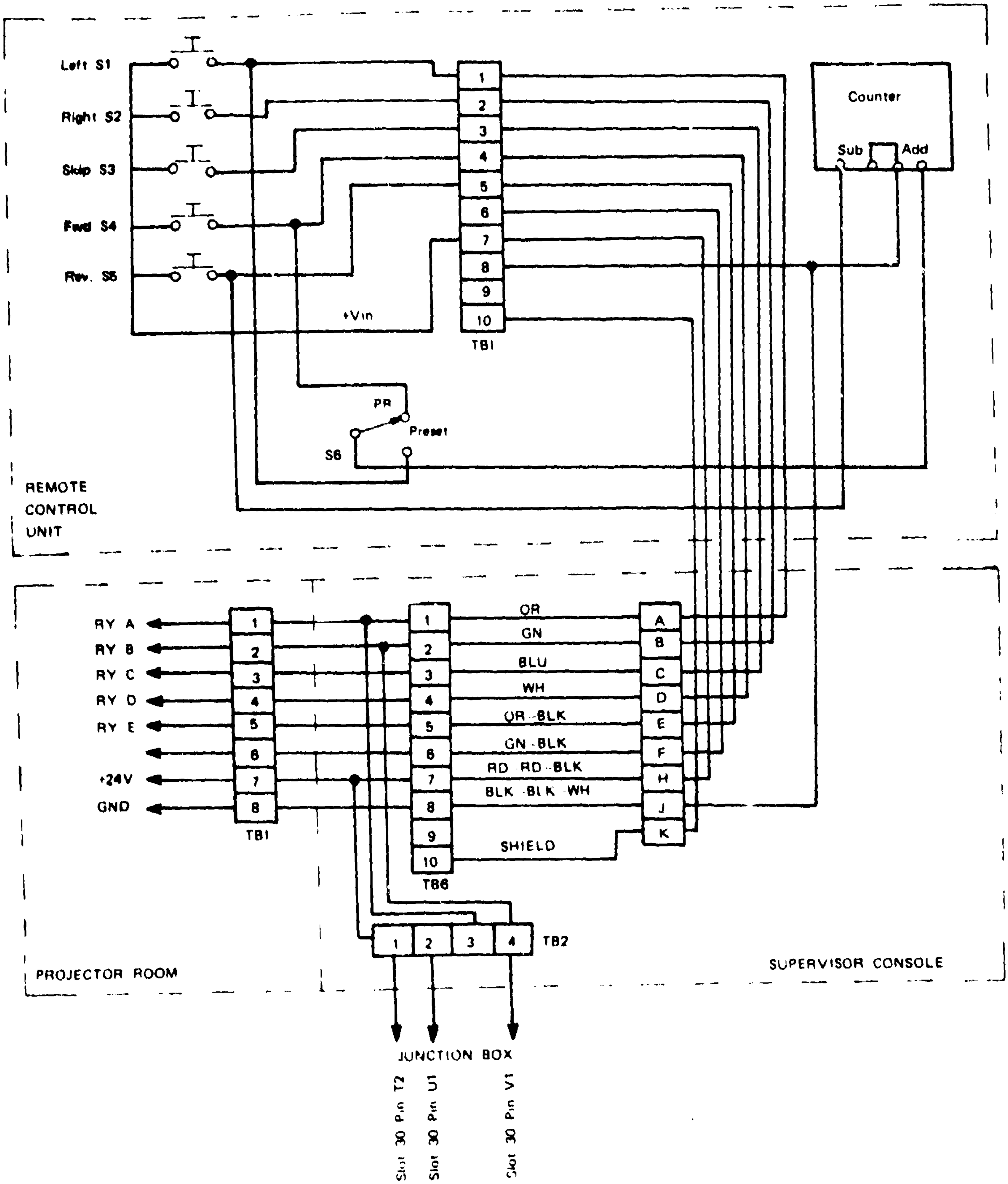


Figure 8.9. Remote Box and Projection Booth Wiring Schematic

NAVIGATIONAL AREA PROGRAMMING PANELS

The GAT–1 is equipped with radio aids which provide for the reception of simulated VOR, ADF, ILS, and marker beacon signals within 120 nautical mile square area. Hardware provisions have been made for two ILS stations, six VOR stations, and four ADF stations. The VOR and ILS signals are tuned by the MARK-12 NAV/COMM tuning head and the related information is displayed on the VOA-9 omnirange bearing indicator. When the MARK-12 is tuned to an ILS station, a visual reception of the marker beacon can be obtained when the aircraft location is coincident with marker beacon ground placement. Aural identification of VOR/ILS and marker beacon signals is provided over the cockpit communication loudspeaker. The aural identification for the VOR/ILS signal is the station's Morse code call, while the marker beacon system provides a continuous beep until the aircraft travels away from the beacon ground location. ADF signals are tuned by the ADF-31A with the bearing information displayed on the associated indicator. A Morse code aural identification is given over the communication loudspeaker.

The GAT--1 is programmed by the manufacturer for an area called Anytown, USA. Typically, station locations, VHF frequencies, and Morse code identification calls are hardwired on the appropriate circuit cards. For the VDS system, two programming modules and one voltage monitoring module allow the navigational system to be changed without hardware alterations on the circuit boards. These Navigational Area Programming panels, located on the back of the Supervisor's Console, are directly linked via cabling to the ADF circuit board (633731E) and the X-Y Station Coordinate circuit board (633727E) in the GAT–1. Pictorial representation of these modules are presented in Figure 9-1.

To achieve flexibility of external programming, modifications were made on the ADF and X-Y Station circuit boards. These changes include removal of jumper cables and resistors necessary for the navigational system of Anytown, USA. In addition, internal potentiometers for altering station locations were removed and replaced on the Navigational Area Programming panels for easy access and monitoring.

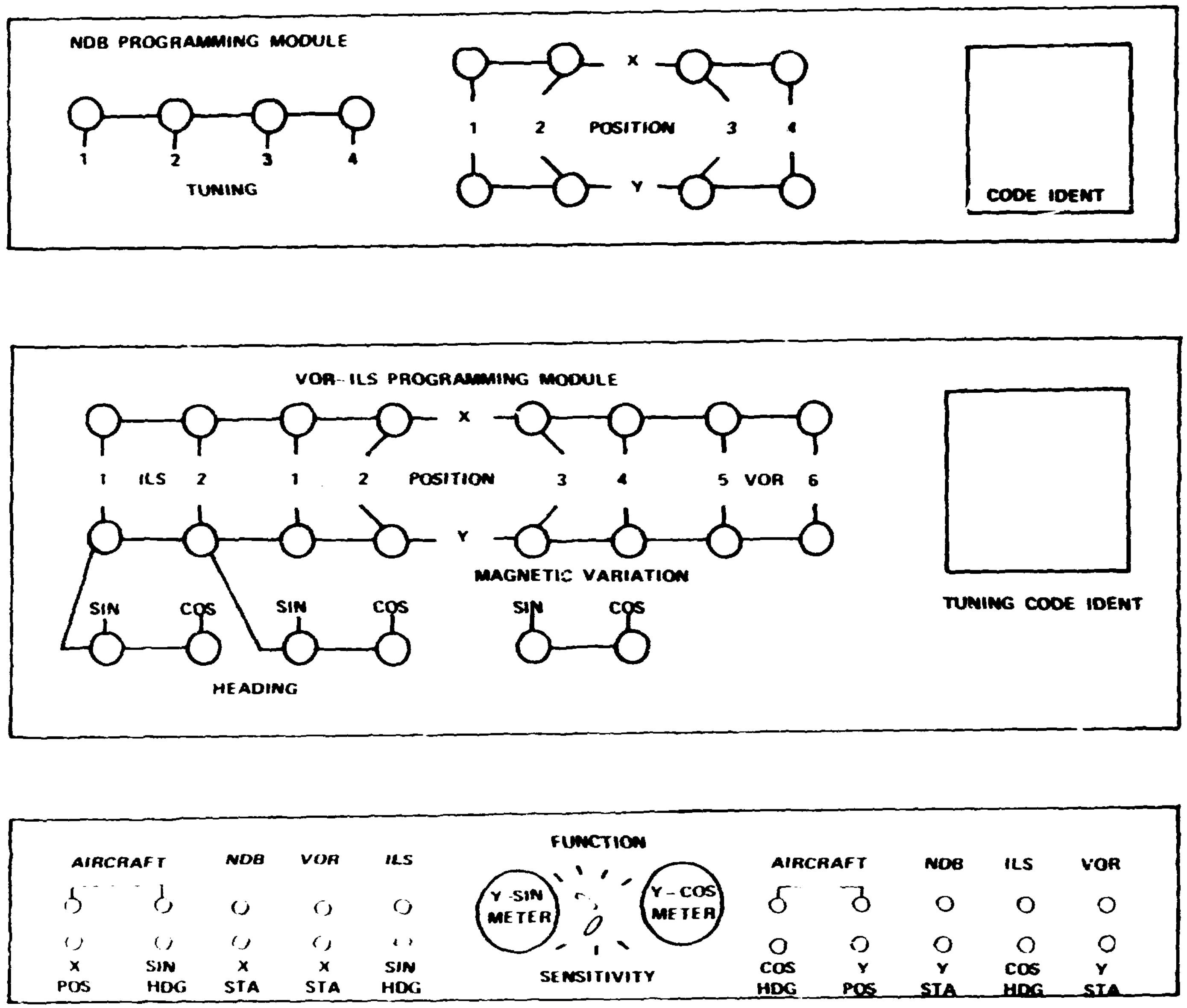


Figure 9-1. Navigational Area Programming Panels

I. DESCRIPTION

A. NON DIRECTIONAL BEACON PROGRAMMING MODULE

This module includes eight potentiometers and a patch panel for programming the reception of simulated ADF signals. Each of the four stations has one potentiometer for setting the station frequency and two for setting the X-Y coordinates of the station location. A patch panel has been provided for programming the first and second Morse code letters of the station's identification call. At present, the panel is not hardwired to the ADF circuit board.

1.	Patch panel inputs	26; A to Z Morse code ID.
2.	Patch panel outputs	4; first letter of Morse code ID.
		4; second letter of Morse code ID.
3.	Potentiometers	4; station frequency; 5K, 10 turn, ±15 VDC.
		4; X position; 20K, 10 turn, ±15 VDC.
		4; Y-position; 20K, 10 turn, ±15 VDC.
4.	Output Destination	ADF 633731E circuit board.
5.	Input Source	ADF 633731E circuit board
6.	Voltage Source	TB1-18, +15 VDC; Supervisor's Console.
		TB1-14, -15 VDC; Supervisor's Console.

B. VOR/ILS PROGRAMMING MODULE

This module includes twenty-two potentiometers and a patch panel. Each of the six VOR and two ILS station has two potentiometers for setting the X-Y coordinates of the station locations. Each ILS station has two additional pots to set the sine and cosine headings required for an ILS approach. There are two pots, sine and cosine, to set the magnetic variation for ILS reference to true runway bearing and VOR reference to magnetic North. The patch panel has outputs for programming the VHF tuning frequencies and the three letter Morse code calls for the eight stations.

1.	Patch Panel Inputs	26; A to Z Morse code ID.
		10; VHF tuning frequency, 108 thru 117.
		10; VHF tuning frequency, .0 thru .9.
2.	Patch Panel Outputs	8; first letter of Morse code ID.
		8; second letter of Morse code ID.
		8; third letter of Morse code ID.
3.	Potentiometers	8; X-position; 15K, 5 turn, ±15 DC
		8; Y-position; 15K, 5 turn, ±15 VDC.
		2; sine heading; 15K, 5 turn, ±15 VDC.
		2; cosine heading; 15K, 5 turn, ±15 VDC.
		1; sine magnetic variation; 15K, 5 turn, ±15 VDC.
		1; cosine magnetic variation; 15K, 5 turn, ±15 VDC.
4.	Output Destination	X-Y Station Coordinate 633727E circuit board.

5. Input Source — X-Y Station Coordinate 633727E circuit board.

6. Voltage Source — TB1-18, +15 VDC; Supervisor's Console.
TB1-14, -15 VDC; Supervisor's Console.

C. VOLTAGE MONITORING PANEL

This module provides connection points for a DVM in order to read output voltages from the potentiometers of the programming modules, and to obtain voltages regarding the X-Y position and heading of the aircraft. Two ammeters have been provided to indicate the X-Y position of the aircraft location in reference to a particular navigational system. There is a rotary switch for selecting either an ILS, VOR, or NDB reference station. A second rotary switch has been provided to change the sensitivity of the microampere readings.

	INPUT	SOURCE
Aircraft	X-position	ADF card, J2-F; ±10 VDC.
	sine heading	ADF card, J3-A; ±10 VDC.
	Y-position	ADF card, J2-J; ±10 VDC.
	cosine heading	ADF card, J3-F; ±10 VDC.
NDB	X-location	ADF card, J2-D; ±10 VDC.
	Y-location	ADF card, J2-A; ±10 VDC.
VOR/ILS	X-location	X-Y Station card, TP1; ±10 VDC.
	Y-location	X-Y Station card, TP2; ±10 VDC.
ILS	sine heading	X-Y Station card, TP4; ±10 VDC.
	cosine heading	X-Y Station card, TP3; ±10 VDC.

II. MODIFICATIONS OF THE GAT-1 CIRCUIT BOARDS

A. ADF CIRCUIT BOARD (633731E)

1. Station Frequencies.
   a. Removed R1,R2; R17,R18; R33,R34; R49,R50.
   b. R1, R17, R33, R49 junction points have been linked via cabling to the respective ADF station tuning pots 1, 2, 3, and 4 on the NDB Programming Module.
   c. Cabling on the ADF card has been labeled accordingly.
2. Station Identification.
   a. Jumper cables to A5 Pins 1, 2, 3, and 4 have been changed for the present programming. See Area Programming Chart in this section.
   b. Jumper cables to A6 Pins 5, 6, 7, and 8 have been changed for the present programming. See Area Programming Chart in this section.
3. Station Positions.
   a. Removed pots R87, R88, R89, R90. Disconnected R13,R14; R15,R16; R29,R30; R31,R32 from the circuit pathway.

b. The connecting terminal point of R87 has been linked via cabling to the X-axis pot for station 1 on the NDB Programming Module; R88 to the Y-axis pot for station 1; R89 to X-axis pot for station 2; and, R90 to the Y-axis pot for station 2.

c. Removed R45,R46; R47,R48; R61,R62; R63,R64.

d. Junction points of R45,R46 have been linked via cabling to the X-axis pot for station 3; R47,R48 to the Y-axis pot for station 3; R61,R62 to the X-axis for station 4; and R63,R64 to the Y-axis for station 4.

e. Cabling on the ADF card has been labeled accordingly.

4. 400 cycle Sine-Cosine Inverter Cards.

a. J2-F on the A8 module has been linked via cabling to the X-axis of aircraft location on the Voltage monitoring Panel; J2-J to the Y-axis of the aircraft location; J2-D to the X-axis of the NDB station location; and J2-A to the Y-axis of the NDB station location.

b. J3-A on the A7 module has been linked via cabling to the sine aspect of the aircraft heading on the Voltage Monitoring Panel; and, J3-F to the cosine aspect of the aircraft heading.

B. X–Y STATION COORDINATE CIRCUIT BOARD (633727E)

1. Station Frequencies.

a. Jumper cables between the station frequency pins and input. Pins 4, 5, 6, 7, to A3; Pins 17, 18, 19, 20, 21, 22, to A2; and Pins 32, 33, 34, 35, 36, 37, to A1 have been removed.

b. The 20 station frequency pins for 108 thru 117 and .0 thru .9 have been linked via cabling to the patch panel on the VOR/ILS Programming Module.

c. Pins 4, 5, 6, 7; Pins 17, 18, 19, 20, 21, 22; and, Pins 32, 33, 34, 35, 36, 37, have been linked via cabling to the patch panel on the VOR/ILS Programming Module. The pin number assignment on the patch panel is identical to the pin number on the X-Y Station card.

2. Station Identification.

a. Jumper cables between the Morse code letters and input Pins 8, 9, 10, to A6; Pins 23, 24, 25, to A5; Pins 38, 39, 40, to A4; Pins 1, 2, 3, to A9; Pins 11, 12, 13, to A8; Pins 26, 27, 28, to A7; Pins 14, 15, 16, to A11; and Pins 29, 30, 31, to A10 have been removed.

b. Morse code letters A thru Z fed to the X-Y station card by the Code ID Card (633735E) have been linked via cabling to the patch panel on the VOR/ILS Programming Module.

c. Input pins for station identification to A4, A5, A6, A7, A8, A9, A10, and A11 have been linked via cabling to the patch panel on the VOR/ILS Programming Module. The pin number assignment on the patch panel is identical to the pin numbers on the X-Y Station card.

3. Station Position.

a. Removed R100,R102; R101,R103; R108,R110; R109,R111; R128,R130; R129,R131; R132,R134; R133,R135; R140,R142; R141,R143; R148,R150; R149,R151; R136,R138; R137,R139; R144,R146; R145,R147.

b. Removed pots R65 thru R80.

c. The connecting terminal point of R65 has been linked via cable to the X-axis pot for VOR station 6 on the VOR/ILS Programming Module; R66 to the Y-axis pot for VOR station 6; R67 to the X-axis pot for VOR station 5; R68 to the Y-axis pot for VOR station 5; R69 to the X-axis pot for VOR station 4; R70 to the Y-axis pot for VOR station 4; R71 to the X-axis pot for VOR station 3; R72 to the Y-axis pot for VOR station 3; R73 to the X-axis pot for VOR station 2; R74 to the Y-axis pot for VOR station 2; R75 to the X-axis pot for VOR station 1; R76 to theY-axis pot for VOR station 1; R77 to X-axis pot for ILS station 2; R78 to Y-axis pot for ILS station 2; R79 to the X-axis pot for ILS station 1; and , R80 to the Y-axis pot for ILS station 1.

d. Removed R112,R113; R118,R119; R114,R115; R120,R121; R116,R117; R112,R123.

e. Junction points of R122,R123 have been linked via cabling to the sine magnetic variation pot on the VOR/ILS Programming Module; and, R116,R117 to the cosine magnetic variation pot.

f. Junction points of R120,R121 have been linked via cable to the sine aspect for ILS station 1; R114,R115 to the cosine aspect for ILS station 1; R118,R119 to the sine aspect for ILS station 2; R112,R113 to the cosine aspect for ILS station 2.

4. Output to VOR/ILS Circuit Board (633723E).

a. TP1 has been linked via cabling to the X-axis of the VOR/ILS station location; and, TP2 to the Y-axis of the VOR/ILS station location.

b. TP3 has been linked via cabling to the cosine aspect of the ILS station location; and, TP4 to the sine aspect of the ILS station location.

III. PROGRAMMING PROCEDURES

A. CHARTS

A navigational chart for a 120 nautical mile square area is required to program the VDS system for the reception of VOR, ADF, ILS, and marker beacon signals. The chart can either be part of an FAA Sectional Aeronautical Chart or a simulated navigational chart such as Anytown developed by Link-Singer Company. When a Sectional Aeronautical Chart is used, Low Altitude Instrument Approach Procedures for the area are required to program the ILS approaches.

It will also be necessary to use the Area Programming Chart shown in Table 9-1. This chart designates the appropriate pin assignments for setting the frequency and Morse code identification of each station on the patch panel. The input required for the circuit boards in the GAT-1 is made by means of these pins. A record of the most recent program should be shown in Table 9-II for future reference and for calibration checks of the GAT-1 system.

B. SPECIAL NOTE

Since navigational instruments are dependent upon magnetic North, special consideration must be given to the magnetic deviation from true North. This is particularly true when programming with a Sectional Aeronautical Chart. The programming procedures, presented below, indicate how to account for the magnetic

variation with VOR and ILS stations. However, the directional gyro in the GAT-1 is set to true North as is the ADF radio compass. Adjustment of these components is required in order to synchronize the GAT-1 system to a navigational area with a magnetic variation. A description of these adjustments is given in the GAT-1 manual, pages 132 and 229. [According to the manual, the directional gyro can be changed by repositioning the heading indicator synchro located on the motion base. This must be done without changing pots R1 and R2. An easier procedure is to change the synchro located on the back of the directional gyro in the cockpit instrument panel. Any change in R1 and R2 would necessitate a recalibration of heading and airspeed which could require changes in the computer program.] Because the computer calculations for heading are based on the sine/cosine analog signal from R1, the heading reference switches on the Supervisor's Console must be in reference to true North instead of magnetic North unless a constant reading error is acceptable. Caution must be employed during an experimental run so that a pilot is given flight information in terms of magnetic North, while the reference values for calculations are in terms of true North.

A method to by-pass these problems is to set up a navigational area with zero magnetic variation. Therefore, true North would be the same as magnetic North. Then, the only adjustment that would need to be made is the wind direction sine/cosine pot if true wind direction was required for the flight scenario. The adjustment can be made by either rotating the wind direction pot case to the appropriate setting or repositioning the selector knob.

When using a Sectional Aeronautical Chart, it will also be necessary to rotate the chart on the X-Y plotter so that magnetic North is placed at the recorder top before programming the navigational stations. A better procedure would be to cut out the required area on a bias which corresponds to the magnetic variation and make horizontal and vertical marks which match the recorder plate on the margins. This technique would make the chart more convenient to use and insure that the map is positioned in the same location every time.

C. PROCEDURES

The programming of the navigational systems is to be performed under the following conditions:

- a. GAT-1 Electrical Power ON.
- b. Servo Systems for Pitch, Roll, and Yaw SHUT DOWN.
- c. Zero Indicated Airspeed.
- d. X-Y Plotter ON.
- e. MARK-12 Panel ON.
  1. Master switch in GAT-1 ON.
  2. Communication Volume Control ON (upper left knob on panel).
  3. IDENT Switch PULLED (upper right knob on panel).
- f. ADF-31 Panel ON.
  1. OFF-REC-ADF Switch to ADF.
  2. Volume Control ON.

1. VOR Stations.

Step 1. Identify six VOR stations on the navigational chart and note the frequencies and code call letters of each station. It is not necessary to program all stations if the navigational area contains less than six VOR stations or if the navigational system is not required for a specific experiment.

Step 2. On the VOR/ILS Programming Module, locate pins marked 1 through 40 on the right hand side of the patch panel. These pins conduct inputs to the GAT–1 for setting the station frequency and Morse code identification calls. Input pin assignments for all stations are designated in Table 9-I.

Step 3. Connect all desired station frequencies, located in the middle of the patch panel, to the appropriate pin numbers. For example, if the desired frequency for VOR station 1 is 108.8, then 108 should be cabled to pin 18 and .8 to pin 17. No other station can have the same frequency; however, part of a frequency, such as .8 or 108, can be used more than one time.

Step 4. Connect the desired Morse code letters, located on the left side of the patch panel, to the appropriate pin numbers. For VOR station 1, the first letter of the ID code should be cabled to pin 25, the second to pin 13, and the third to pin 15. Any Morse code letter can be used as many times as necessary.

Step 5. Select each frequency with the Navigational Tuning Head, the middle knob on the left of MARK-12 panel, to check the aural presentation of the Morse code identification calls. Be sure the volume has been turned up and the IDENT button has been pulled out. If the calls are not corroct, reprogram. If problems persist, notify the proper personnel to check the X-Y station and Code ID circuit boards in the GAT–1.

Step 6. Position the navigational chart on the X-Y recorder. The recorder face plate is marked with a vertical and a horizontal line which cross at the edges of the face plate. Align the map with the face plate lines. Since it is imperative to place the map in the same place every time, vertical and horizontal lines which correspond with the face plate lines should be marked on the margins of the map.

Step 7. Turn recorder ON.

Step 8. Select station 1 frequency with the Navigational Tuning Heads.

Step 9. Locate VOR station 1 on the map.

Step 10. Slew the aircraft over the VOR symbol on the map which corresponds to station 1. To slew the aircraft, use the E-W and N-S toggle switches.

Step 11. Connect a DVM (Digital Voltmeter) to the ± plug for aircraft X-position.

Step 12. Record the voltage. If the voltage is rapidly changing and movement of aircraft position is detectable on the plotter, notify proper personnel to check the drift on the X-Y aircraft circuit board in the GAT–1.

Step 13. Connect the DVM to the ' plug for aircraft Y-position; record voltage.

Step 14. Connect the DVM to the ' plug for VOR X-position.

Step 15. Set the X-pot for VOR station 1 to the same voltage obtained in Step 12 for the aircraft X-position. If adjustment of the pot does not change the voltage readings, check to see that station 1 has been correctly selected on the Navigational Tuning Heads.

Step 16. Connect the DVM to the ' plug for VOR Y- position.

Step 17. Set the Y-pot for VOR station 1 to the same voltage obtained from Step 13 for the aircraft Y-position.

Step 18. Repeat Steps 7 through 17 for each of the VOR stations.

2. Magnetic Deviation.

Step 1. Determine the variation required in degrees to set a magnetic North. With a simulated navigational chart, magnetic North and true North should be identical. With a Sectional Aeronautical Chart, the value associated with the magenta isogonic line is a magnetic variation. Be sure to note if the variation value is East or West.

Step 2. Find the sine and cosine of this variation. When magnetic North and true North are identical, the sine value equals 0 and the cosine equals +1. For a 3° E magnetic variation, the sine value equals +.0523 and the cosine equals +.9986. However, if the magnetic variation is 3° W, sine and cosine values need to be found for 357° which results in a sine value of -.0523 and a cosine value of +.9986.

Step 3. Multiply the sine and cosine values by 10. Reverse the sign of the value, e.g., a +5 becomes a -5. This gives the voltage values for setting the potentiometers.

Step 4. Make sure the Navigational Communication System is ON.

Step 5. Select a VOR station frequency on the Navigational Tuning Head.

Step 6. Connect a DVM to the [illegible] plug for ILS sine.

Step 7. Set the magnetic deviation sine pot to the voltage obtained in Step 3.

Step 8. Connect a DVM to the [illegible] plug for ILS cosine.

Step 9. Set the magnetic deviation cosine pot to the voltage obtained in Step 3.

3. VOR and magnetic deviation programming check.

Step 1. Select VOR station 1 on the Navigational Tuning Head.

Step 2. Slew the GAT–1 due South on the 180° radial.

Step 3. In the GAT, set the OMNI bearing selector (outer dial) to 180° using the knob at the base of the VOR instrument.

Step 4. The VOR course indicator should read TO station and the course deviation needle should be in a vertical position with 180° at the top and 0° at the bottom.

Step 5. Slew the GAT-1 to the 175° South radial. The course deviation needle should have a left deflection.

Step 6. Set the OMNI bearing selector to 175°. The course deviation needle should center.

Step 7. Slew the GAT-1 over the VOR symbol. The TO-OFF-FROM flag should go to OFF and the course deviation needle should be centered.

Step 8. Slew the GAT-1 North on the 0° radial. Set the OMNI bearing selector to 0°. The TO-OFF-FROM flag should read FROM with the course deviation needle centered.

Step 9. Repeat Steps 1 through 6 for each station.

Step 10. If a problem occurs, check programming. Should the problem persist, notify the proper personnel to check the X-Y station card, VOR/ILS card, and the sine/cosine inverters.

4. ILS Stations.

Step 1. Identify two stations which are to be used for instrument landings on the navigational chart and note the frequencies and code call letters of each station. It is not necessary to program the ILS stations, if they are not necessary for a specific flight plan.

Step 2. Connect the desired station frequencies to the appropriate pin numbers. Refer to VOR stations Steps 2 and 3.

Step 3. Connect the desired Morse code letters to the appropriate pin numbers. Refer to VOR stations Step 4.

Step 4. Select each frequency with the Navigational Tuning Head to check the aural presentation of the Morse code identification calls. Refer to VOR station Step 5.

Step 5. With the X-Y recorder on and the chart correctly positioned, locate ILS station 1.

Step 6. Check the Low Altitude Instrument Approach plates and obtain the runway heading for ILS station 1.

Step 7. Correct the runway heading by the amount of magnetic deviation in order to obtain the runway bearing in reference to true North. For example, a runway heading of 153^{o} and a magnetic variation of 3^{o} E makes the true runway bearing 150^{o}. Always subtract the East variation and add the West variation.

Step 8. Obtain the sine and cosine values for the true runway bearing.

Step 9. Multiply the sine and cosine values by 10.

Step 10. Select ILS station 1 on the Navigational Tuning Head.

Step 11. Slew the aircraft to the middle of the appropriate runway.

Step 12. Connect a DVM to the ' plug for aircraft X-position and record the voltage.

Step 13. Connect the DVM to the ' plug for aircraft Y-position and record the voltages.

Step 14. Connect the DVM to the ' plug VOR X-position.

Step 15. Set the X-pot for ILS station 1 to the same voltage obtained from Step 12.

Step 16. Connect the DVM to the ' plug VOR Y-position.

Step 17. Set the Y-pot for ILS station 1 to the same voltage obtained from Step 13.

Step 18. Connect the DVM to the ' plug ILS sine.

Step 19. Set the sine pot for ILS station 1 to the sine value obtained in Step 9.

Step 20. Set the cosine pot for ILS station 1 to the cosine value obtained in Step 9.

Step 21. Repeat Steps 6 through 20 for station 2.

NOTE: The middle marker and outer marker beacon signals are automatically computed in the GAT-1 circuitry from the station location and runway bearing. The outer marker is set at 6 nautical miles from the station, while the middle marker is set at 2.26 nautical miles. The aural presentation of the outer marker is a 400 Hz signal in the form of dashes and the middle marker is a 1300 Hz signal in a series of alternate dots and dashes.

5. ILS Programming Check.

Step 1. Select ILS station 1 on the Navigational Tuning Head.

Step 2. Slew the GAT-1 so that it is on an approach path to the appropriate runway. The VOA-9 instrument should read TO station, the glide slope indicator should show a fly-up condition if in range of the navigational system, and the glide slope OFF flag should disappear.

Step 3. Slew the GAT along the approach pathway. Monitor the LEFT-RIGHT and the glide slope indicator to see if the proper needle readings are obtained. The LEFT-RIGHT needles depend on the aircraft location while the glide slope indicator should always read fly up. Approximately at 6 nautical miles the outer marker should become active and the middle marker at 2.26 nautical miles.

Step 4. Slew the GAT to the middle of the runway. The glide slope indicator should level and the glide slope OFF flag should appear.

Step 5. Slew the GAT past the station. The glide slope indicator should be OFF and the course deviation needle should reflect aircraft location in respect to the radial.

6. ADF Stations.

Step 1. Identify four ADF stations on the navigation chart and note the frequency and code call letters of each station. It is not necessary to program all stations.

Step 2. The Morse identification call for each station must be programmed on the ADF card. Connect the desired Morse code letter to the appropriate pin numbers designated in Table 9-1. The placement of the jumper cards on the ADF card should be done by qualified personnel.

Step 3. Turn knob on the ADF-31 panel to REC and the volume knob counterclockwise.

Step 4. Turn ADF Tuning Head to the desired frequency for station 1.

Step 5. Turn station 1 tuning pot on the NDB Programming Module until the Morse code identification call can be distinctly heard. The tuning needle should have maximum deflection to the right.

Step 6. Detune ADF, then return. Adjust the NDB tuning pot if necessary.

Step 7. Repeat Steps 4, 5, and 6 for stations 2, 3, and 4.

Step 8. Locate ADF station 1.

Step 9. Slew the aircraft over the direct center of the radio beacon.

Step 10. Connect a DVM to the ' plug for aircraft X-position, record the voltage.

Step 11. Connect the DVM to the ' plug for aircraft Y-position, record the voltage.

Step 12. Connect the DVM to the ' plug for ADF X-position.

Step 13. Set the X-pot for ADF station 1 to the same voltage obtained in Step 10 for the aircraft X-position.

Step 14. Connect the DVM to the ' plug for the ADF Y-position.

Step 15. Set the Y-pot for ADF station 1 to the same voltage obtained in Step 11 for the aircraft Y-position

Step 16. Repeat Steps 9 through 15 for each of the ADF stations.

7. ADF Programming Check.

Step 1. Tune in ADF station 1

Step 2. Slew the GAT 1 due North of the station

Step 3. Check to see that the correct tuning shows a maximum deflection of the tuning meter.

Step 4. Check the Morse code identification call.

Step 5. Set the directional gyro to 180° (Turn master switch ON, ignition ON, push in throttle to gain airspeed and ENERGIZE the yaw motion switch. Use the rudder pedals to change the aircraft to a 180° heading. Shut OFF the yaw motion switch.)

Step 6. Set the radio compass to 180°. The ADF indicator should be in a true vertical position with the needle pointing to 180°. Be sure to account for the magnetic deviation of the programmed area. Refer to Part B, Special Note, under Programming Procedures.

Step 7. Depress the push-to-test button on the ADF panel. The ADF indicator should rotate approximately 120 degrees counterclockwise.

Step 8. Slew the aircraft due South of the station. The ADF indicator should be pointed to 0°.

Step 9. Slew the GAT-1 due West of the station. The ADF indicator should point East.

Step 10. Slew the GAT-1 due East of the station. The ADF indicator should point West.

Step 11. Repeat Steps 4 through 10 for each ADF station.

Step 4. Slew the GAT to the middle of the runway. The glide slope indicator should level and the glide slope OFF flag should appear.

Step 5. Slew the GAT past the station. The glide slope indicator should be OFF and the course deviation needle should reflect aircraft location in respect to the radial.

6. ADF Stations.

Step 1. Identify four ADF stations on the navigation chart and note the frequency and code call letters of each station. It is not necessary to program all stations.

Step 2. The Morse identification call for each station must be programmed on the ADF card. Connect the desired Morse code letter to the appropriate pin numbers designated in Table 9-1. The placement of the jumper cards on the ADF card should be done by qualified personnel.

Step 3. Turn knob on the ADF-31 panel to REC and the volume knob counterclockwise.

Step 4. Turn ADF Tuning Head to the desired frequency for station 1.

Step 5. Turn station 1 tuning pot on the NDB Programming Module until the Morse code identification call can be distinctly heard. The tuning needle should have maximum deflection to the right.

Step 6. Detune ADF, then return. Adjust the NDB tuning pot if necessary.

Step 7. Repeat Steps 4, 5, and 6 for stations 2, 3, and 4.

Step 8. Locate ADF station 1.

Step 9. Slew the aircraft over the direct center of the radio beacon.

Step 10. Connect a DVM to the + plug for aircraft X-position; record the voltage.

Step 11. Connect the DVM to the + plug for aircraft Y-position; record the voltage.

Step 12. Connect the DVM to the + plug for ADF X-position.

Step 13. Set the X-pot for ADF station 1 to the same voltage obtained in Step 10 for the aircraft X-position.

Step 14. Connect the DVM to the + plug for the ADF Y-position.

Step 15. Set the Y-pot for ADF station 1 to the same voltage obtained in Step 11 for the aircraft Y-position.

Step 16. Repeat Steps 9 through 15 for each of the ADF stations.

7. ADF Programming Check.

Step 1. Tune in ADF station 1.

Step 2. Slew the GAT-1 due North of the station.

Step 3. Check to see that the correct tuning shows a maximum deflection of the tuning meter.

Step 4. Check the Morse code identification call.

Step 5. Set the directional gyro to 180°. (Turn master switch ON, ignition ON; push in throttle to gain airspeed; and ENERGIZE the yaw motion switch. Use the rudder pedals to change the aircraft to a 180° heading. Shut OFF the yaw motion switch.)

Step 6. Set the radio compass to 180°. The ADF indicator should be in a true vertical position with the needle pointing to 180°. Be sure to account for the magnetic deviation of the programmed area. Refer to Part B, Special Note, under Programming Procedures.

Step 7. Depress the push-to-test button on the ADF panel. The ADF indicator should rotate approximately 120 degrees counterclockwise.

Step 8. Slew the aircraft due South of the station. The ADF indicator should be pointed to 0°.

Step 9. Slew the GAT-1 due West of the station. The ADF indicator should point East.

Step 10. Slew the GAT-1 due East of the station. The ADF indicator should point West.

Step 11. Repeat Steps 4 through 10 for each ADF station.

TABLE 91

GAT I AREA PROGRAM

AREA	MAG VAR °		VOLTS	DIV		VOLTS	DIV
		X			Y		

ILS PROGRAM

•	NAME	[illegible]	FREQUENCY 100's	TO	10's	TO	CODE IDENT 1st	TO	2nd	TO	3rd	TO	X POSITION VOLTS	DIV	Y POSITION VOLTS	DIV	SIN VOLTS	HDG DIV	COS VOLTS	DIV
1				5		4		9		3		10								
2				7		6		8		2		14								

VOR PROGRAM

•	NAME	FREQUENCY 100's	TO	10's	TO	CODE IDENT 1st	TO	2nd	TO	3rd	TO	X POSITION VOLTS	DIV	Y POSITION VOLTS	DIV
1			18		17		25		13		15				
2			20		19		24		11		16				
3			22		21		23		12		29				
4			33		32		40		28		30				
5			35		34		39		26		31				
6			37		36		38		27		1				

NDB PROGRAM

•	NAME	FREQUENCY	DIV	CODE IDENT 1st	TO	2nd	TO	X POSITION VOLTS	DIV	Y POSITION VOLTS	DIV
1					2		1				
2					4		3				
3					6		5				
4					8		7				

TABLE 9-II

GAT I AREA PROGRAM

AREA	MAG VAR		VOLTS	DIV		VOLTS	DIV
	3° E	X	.523	244	Y	9.986	081

ILS PROGRAM

•	NAME	True Runway Bearing	FREQUENCY 100's	TO	10's	TO	CODE IDENT 1st	TO	2nd	TO	3rd	TO	X POSITION VOLTS	DIV	Y VOLTS	DIV	SIN VOLTS	HDG DIV	COS VOLTS	DIV
1	PENSACOLA	160°	109	5	5	4	P	9	N	3	S	10	+4.330	323	3.837	178	+3.42	258	−9.40	058
2	BATES	317°	111	7	5	6	A	8	I	2	L	14	6.[illegible]5	141	1.301	228	−6.82	135	+7.31	321

VOR PROGRAM

•	NAME	FREQUENCY 100's	TO	10's	TO	CODE IDENT 1st	TO	2nd	TO	3rd	TO	X POSITION VOLTS	DIV	Y POSITION VOLTS	DIV
1	SAUFLEY	108	18	8	17	N	25	V	13	N	15	+2.816	592	3.922	185
2			20		19		24		11		16				
3	CRESTVIEW	115	22	9	21	C	23	E	12	W	29	+9.552	426	+0.193	253
4	BROOKLEY	112	33	8	32	B	40	F	28	M	30	4.448	176	2.202	217
5	MOBILE	115	35	3	34	M	39	O	26	B	31	7.468	124	.841	239
6	GREENCOUNTY	110	37	4	36	G	38	C	27	V	1	8.630	103	+3.703	265

NDB PROGRAM

•	NAME	FREQUENCY	DIV	CODE IDENT 1st	TO	2nd	TO	X POSITION VOLTS	DIV	Y POSITION VOLTS	DIV
1	PICKENS	326	211	P	2	N	1	+4.383	347	4.313	647
2	PENSACOLA	215	068	N	4	P	3	+2.792	402	5.292	679
3	WHITING	368	266	N	6	S	5	+5.475	311	.449	512
4	PASCAGOULA	284	165	P	8	P	7	8.930	805	4.957	670

GAT–1 SIMULATOR

The information in this section should be supplemented, for purposes of troubleshooting mechanical or electrical problems, by manuals provided by the manufacturer. Detailed information on the trainer can be found in the three GAT–1 manuals located in the VDS facility. These manuals are entitled Operations and Maintenance Manual, Detail Circuit Description, and GAT–1 Schematics.

Several part arrangements which are important to the contents of this manual have been included for reference. Figure 10-1 depicts the location of the circuit boards in the card bin. Table 10-I gives the pin assignments for the circuit boards. Figure 10-2 illustrates the cockpit instrument panel followed by a description guide in Table 10-II. Other part layouts for the GAT–1 which have been included elsewhere in the manual are as follows. Figure 8-1 in Section VIII, depicts the flight parameter controls for the trainer which are located on the Supervisor's Console. These controls were initially on the instructor's panel located on the side of the GAT–1. Figure 9-1 in Section IX illustrates the panel layout of the Navigational Area Programming Panels. These panels are a modification of the GAT–1 and have been added to the circuitry for readily programming the navigational systems. Location of other major parts can be found in the Operations and Maintenance Manual, and the internal cable assembly for the trainer are depicted in the GAT–1 Schematics manual.

J25	633739	Power Amplifier (Pitch)
J24	633739	Power Amplifier (Bank)
J23	633739	Power Amplifier (Turn)
J22	633745	Attitude
J21	633713	Time Division
J20	633743	Relative Wind
J19	633737	Altitude
J18	633715	Engine
J17	Blank	
J16	633733	Engine Sound
J15	633711	Rough Air
	Spare	
	Spare	
	Spare	
	Spare	
J10	633721	Marker Beacon
J9	633723	VOR/ILS
J8	633749	Glide Slope
J7	633714	Master Logic
J6	633712	X -Y Aircraft
J5	633731	ADF
J4	633735	Code I.D.
J3	633735	Code I.D.
J2	633727	X–Y Station
J1	633729	Communication

Figure 10-1. GAT–1 Card Bin Layout

Table 10-I

GAT–1 Circuit Board Pin Assignments

$\overline{Y}$	43
$\overline{X}$	42
$\overline{W}$	41
$\overline{V}$	40
$\overline{U}$	39
$\overline{T}$	38
$\overline{S}$	37
$\overline{R}$	36
$\overline{P}$	35
$\overline{N}$	34
$\overline{M}$	33
$\overline{L}$	32
$\overline{K}$	31
$\overline{J}$	30
$\overline{H}$	29
$\overline{F}$	28
$\overline{E}$	27
$\overline{D}$	26
$\overline{C}$	25
$\overline{B}$	24
$\overline{A}$	23
Z	22
Y	21
X	20
W	19
V	18
U	17
T	16
S	15
R	14
P	13
N	12
M	11
L	10
K	9
J	8
H	7
F	6
E	5
D	4
C	3
B	2
A	1

When facing the rear of the circuit card installation, these numbers reflect the pin configuration of printed circuit card connectors except for the Power Regulator and Paddle Boards. The Power Regulator (J27) is numbered in reverse order with A–1 at the top. The flight Paddle Boards J39 and J36 are numbered A–1 through $\overline{R}$–36 with A–1 at the left. The radio aids Paddle Boards J11 and J29 are numbered A–1 through $\overline{Y}$–43 and A–1 through $\overline{R}$–36, respectively, with A–1 at the right.

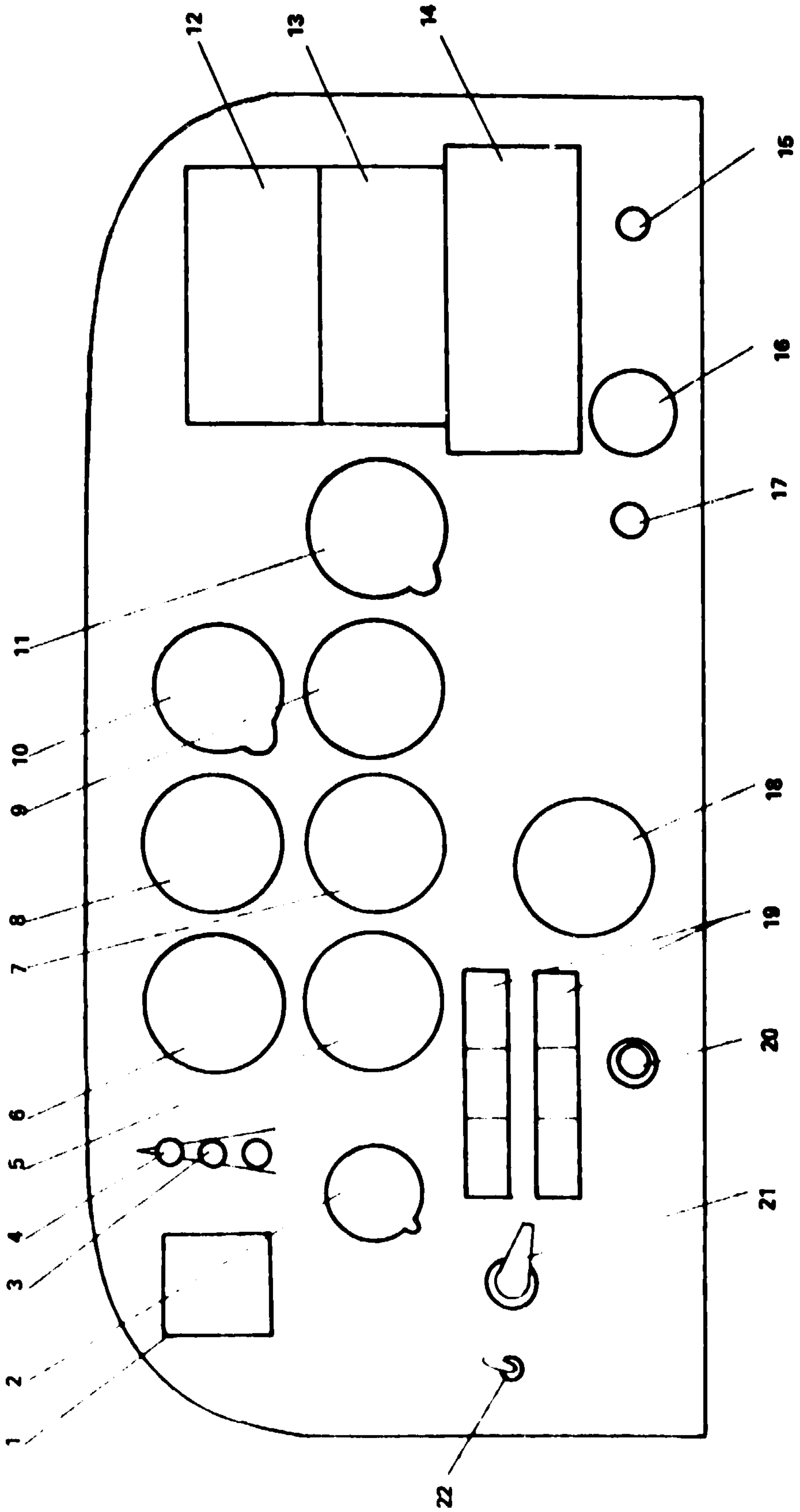


Figure 10-2. GAT-1 Instrument Panel

Table 10-11

INSTRUMENT PANEL DESCRIPTION GUIDL

Index No.	Part
1	Time Lapse Meter
2	Clock
3	Middle Marker Indicator Light
4	Outer Marker Indicator Light
5	Turn & Slip Indicator
6	Airspeed Indicator
7	Directional Gyro
8	Attitude Gyro
9	Rate of Climb Indicator
10	Altimeter
11	VOR-ILS-Glide Slope Indicator
12	ADF-31A Control Panel
13	MARK 12A Control Panel
14	Distance Measuring Equipment
15	Air Mixture Control
16	Throttle
17	Carburetor Heat Control
18	RPM Indicator
19	Engine Cluster
20	Instrument Lights Control
21	Ignition
22	Master Switch

I. CAUTIONS

A. Motion switches for roll, pitch, and yaw must be off before turning the trainer on or off.
B. A tire screech sound must be audibly present when the trainer is initially turned on. If not, turn system off and locate problem.
C. Trainer power must be turned off prior to removing or replacing components.
D. DO NOT put hands or tools on the back of the fixed base power entrance plate without disconnecting the power plug to the trainer.
E. Do not rotate the GAT horizontally unless all cabling to the Supervisor's Console has been disconnected and the heading pots R1,R2 assembly has been moved.

II. TURN ON PROCEDURES

A. GAT-1 POWER ON

1. Roll, Pitch, and Yaw motion switches OFF.
2. Turn Key ON.
3. Push red power button. The tire screech must be audible when the trainer is turned on. If not, quickly turn power off and notify proper personnel.

B. ENGINE ON

1. Insure that the parking brake is on (aft position).
2. See that the CARB HEAT control is OFF (forward position).
3. Crack the throttle (push forward slightly).
4. Turn the MASTER switch to ON.
5. Set the MIXTURE control to its full rich position (forward position).
6. Start the engine by setting the IGNITION control to the START position momentarily and returning it to the BOTH position. The tachometer should indicate 550 (+30) rpm.

C. PRE-FLIGHT CHECK

1. Check OIL PRESSURE, OIL TEMPERATURE, CYLINDER HEAD TEMPERATURE, and FUEL gauges to insure that all needles are in the green regions. If not, adjust the controls on the Supervisor's Console.
2. Set the altimeter barometric pressure reading to 30.00 by adjusting the knurled knob on the indicator.
3. The altimeter should read zero feet. If not, adjust the FIELD ELEVATION control on the Supervisor's Console.
4. Insure that the CENTER OF GRAVITY control on the Supervisor's Console is set to 25%, GROSS WEIGHT to 1600 lbs., OUTSIDE AIR TEMPERATURE is set to standard, WIND VELOCITY is set at 0 knots (turned fully counterclockwise) and the ROUGH AIR is OFF.
5. If the X-Y recorder is to be used, place the ON/OFF switch ON and turn the mode switch to NORM.

NOTE. For takeoff procedure, refer to GAT-1 Flight Check, Part A. Energize the pitch, roll, and yaw motion switches for flight.

III. SHUTDOWN PROCEDURES

A. PILOT INSTRUMENT PANEL

1. Pull PARKING BRAKE aft.
2. Adjust the throttle to idle.
3. Set the Mixture control to full lean.
4. Set the IGNITION switch to OFF.
5. Set the MASTER switch to OFF.

B. RECORDER CONTROL PANEL

1. At the recorder control panel, turn the MODE switch to the ZERO position.
2. Place the ON/OFF switch to the OFF position.

C. POWER PANEL

1. Deactivate the three motion switches (Pitch, Roll, and Yaw). Always deactivate these switches before turning power OFF.
2. Depress the POWER button to OFF.
3. Turn the key-lock switch OFF.

IV. ATTITUDE GYRO REALIGNMENT

A. Occasionally, the indicated bank angle denoted on the attitude indicator gets out of synchronization with the true bank angle of the aircraft. There are four different ways to resynchronize the indicated bank angle. These procedures are presented on pages 110 and 111 in the GAT-1 Detailed Circuit Description Manual. The best method for personnel of limited skill is as follows:

Step 1. Roll, Pitch, and Yaw motion switches OFF.

Step 2. Red power button OFF.

Step 3. Disengage bank motion brake solenoid pin flange by pressing the spring back just enough for the flywheel to turn. Allow trainer to bank in direction which agrees with the indicator. It may be necessary to initially control the flywheel manually. If the brake is completely released, the flywheel will spin rapidly. Watch fingers or tools.

Step 4. Release spring on the solenoid pin flange at the appropriate bank angle.

Step 5. Insure that all motion switches are OFF.

Step 6. Turn red power button ON.

Step 7. Turn bank motion switch ON.

Step 8. Check to see that the bank angle on the indicator returns to zero with the bank angle of the aircraft leveling. [It may be necessary to repeat the above steps several times to properly synchronize the indicated bank angle and the true bank angle of the aircraft.]

B. To prevent desynchronization of the indicated bank angle, always land the trainer and shut all motions switches OFF before truning trainer power off. In addition, make sure the cockpit is level before turning the trainer ON. Use the above procedures to level the aircraft.

V. MODIFICATIONS

A. HEADING

1. Pots R1,R2 and related syncho assembly have been relocated to the side of the motion based system.
2. The heading V–belts have been disconnected thus preventing actual yaw motion of the aircraft. Both the instrument indicators and heading calculations of the system remain sensitive to pilot control.
3. A brace added to the fixed base system secures the motion base system in a permanent position.

B. INSTRUCTOR'S PANEL

1. With the exception of the three motion switches, the turn key, and push power button, the instructor's panel has been relocated to the Supervisor's Console. See Figure 8-1 in Section VIII for the panel layout.
2. The field elevation switch has been replaced with 10 turn, 10K potentiometer. Calibration of this signal is presented in Section VI, Analog Signals.
3. The wind direction potentiometer has been rewired so that Pin 2 on the sine/cosine pot is connected to J6-41 (-Vw Cos ψ w); and Pin 4 is connected to J6-15 (-Vw Sin ψ w).

C. ADF CIRCUIT BOARD (633731E)

See Section IX, Navigational Area Programming Panels, for the modifications.

D. X Y STATION CIRCUIT BOARD (633727E)

See Section IX, Navigational Area Programming Panels, for the modifications.

E. DME

1. A digital voltmeter, which serves as distance measuring equipment (DME) from VOR/ILS stations, has been added to the cockpit instrument panel below the MARK 12A Unit.
2. The input to the DME comes from J9-24 (VOR/ILS Card, 633723E).
3. A potentiometer, located in the nose of the aircraft, is used for adjustment of the input signal.

F. REPEATER GAUGES AND ANALOG INPUT TO PDP 8/e

1. Five gauges have been mounted on the Supervisor's Console to monitor altitude, indicated airspeed, rate of climb, heading, and VOR/ILS deviation of the aircraft during flight. Signal input for the gauges originate from the GAT-1. See Figure 8-4 in Section VIII, Supervisor's Console, for the wiring diagram. Detailed information concerning these signals can be found in Section VI, VDS Analog Signals and Section III, VDS Computer Configuration.

G. TERMINAL BOARDS

1. Additional terminal boards 1, 2, and 3 have been attached inside the tail section near the instructor's panel. These boards serve as junction points in the GAT-1 for connecting the cabling of the instructor panel controls located on the Supervisor's Console to the GAT-1 circuitry at J41 and P32. See Figure 8-5 in Section VIII, Supervisor's Console, for the wiring diagram.
2. Terminal board 4 has been attached to the chassis on the closed side of the card bin. This board serves as a junction point in the GAT-1 for the heading, rate of climb, and VOR/ILS deviation repeater gauges on the Supervisor's Console. See Figure 8-4 in Section VIII, Supervisor's Console, for the wiring diagram.

VI. GAT-1 CALIBRATION TEST PROCEDURES

The following instructions provide step-by-step procedures to calibrate the GAT-1. Only qualified personnel should do the testing.

Step 1. Remove all the printed circuit boards from the upper level of the card bin.

Step 2. Turn the GAT-1 electrical power ON.

Step 3. Check fans.

Step 4. Check the +15 VDC (E10), -15 VDC (E9), +3.6 (E8), and 26 VDC 400 Hz (J28-6, 7) power sources. See System Diagram A1.

Step 5. Adjust the power supplies as needed. See System Diagrams A3-1, A3-2, and A4. If the ± 15 VDC power sources need adjusting, set +15 VDC first, then -15 VDC.

Step 6. Adjust the following:

At	Adjust	For	System Diagram
J21-38	Roll Sine/Cosine Pot R2 on motion base.	-15 VDC	16
J22-30	Roll Sine/Cosine Pot R2 on motion base.	0 VDC	16
J22-21	Pitch Sine/Cosine Pot R3 on motion base (+ up, - down).	0 VDC*	15, 18
J22-24	Elevator Pot R4 on shelf in aircraft nose (+ up, - down).	0 VDC at 0°	15
J22-31	Aileron Pot R5 on shelf in aircraft nose (+ left, - right).	0 VDC at 0°	16
J22-16	Rudder Pot R6 in aircraft nose under flooring (+ left, - right).	0 VDC at 0°	17

At	Adjust	For	System Diagram
J22-26	Elevator Trim Pot R12 in aircraft nose on trim tab (+ up, - down)	3.5 VDC at 0^{o}	15
J22-Y	Center of Gravity Pot on Supervisor's Console (+15V, 35%; -15V, 15%)	0 VDC at 25%	15
J20-19	Outside Air Temperature Pot on Supervisor's Console (+15V, -50^{o}; -15V, 50^{o})	0 VDC at STD	10
J20-H	Gross Weight Pot on Supervisor's Console (+15V, 2100 lbs.; -15V, 1100 lbs.)	0 VDC at 1600 lbs.	11
J19-42	Barometric Pressure Pot on Supervisor's Console (+15V, 31"; -15V, 29"). This VDS analog signal is calibrated in Section VI, Part III.)	0 VDC at 30"	13
J18-13	Air Mixture Pot R1 on shelf in aircraft nose (AFT, Cutoff, +15V; FWD, Rich, +10V)	+10 VDC for Full Rich	7
J18-17	Carburetor Heat Pot R3 on shelf in aircraft nose (AFT, On, -5V, FWD, Off, 0 V)	0 VDC at Off	7
J18-27	Throttle Pot R1 on shelf in aircraft nose (AFT, 550 RPM, -4V; FWD, 24600 RPM, 0 V)	0 VDC at 2460	7

*NOTE: For most VDS experiments, the GAT-1 should have a slight nose down condition in order for the subject to view the entire screen. Therefore, J22-21 should be :287 VDC.

Step 7. Turn the GAT-1 OFF.

Step 8. Insert X-Y Aircraft (J-6) and Relative Wind (J-20) circuit boards.

Step 9. Put switch 1 and switch 2 on the X-Y aircraft card in a downward position. Turn the GAT-1 ON; adjust the following:

At	Adjust	For	System Diagram
J6-S	Wind velocity Pot on Supervisor's Console	+10 VDC at 100 knots, 0 VDC at 0 knots	22-2

Step 10. Set the wind velocity Pot to maximum. Adjust the following:

At	Adjust	For	System Diagram
J6-15	Wind direction Pot on Supervisor's Console	0 VDC at North +10 VDC at East	22-2

Step 11 Put the switch on the Relative Wind Card in a downward position. Adjust Pot R66 on the card for a 100 MPH indication on the airspeed indicator. Adjust the following

At	Adjust	For	System Diagram
J6-18	Heading Pot R2 located on the motion base or synchro on back of the cockpit directional gyro indicator	0 VDC for North 0 VDC for South -10 VDC for East +10 VDC for West	22-2
J5-H	ADF Heading Pot R1 located on the motion base or synchro on the cockpit ADF tuning panel radio compass indicator	0 VDC for North 0 VDC for South -10 VDC for East +10 VDC for West	31-1

Use the following method to change the heading of the aircraft. Energize the yaw servo system. Set the Directional Gyro Indicator to the desired heading using the rudder controls. (Airspeed is required to enable the yaw servo system.) When the heading indication is reached, shut down the yaw servo system and record the voltage

Refer to the heading calibration table in Section VI, entitled VDS Analog Signals, Part III. Do not adjust Pots R1 and R2 unless absolutely necessary. If the pots are changed, new calibration tables for heading and airspeed will be required. In addition, the computer calculations of the analog signals must be checked since programming changes may be necessary. See Section VI, Part VI, Calibration Check with the Computer Program.

Step 12. Readjust Pot R66 on the Relative Wind card for a 0 MPH indication and return the switch on the card to an upward position. Turn the yaw servo system OFF.

Step 13. Turn the GAT-1 OFF; insert the remaining flight and radio aid circuit boards in the card bin; and, turn GAT-1 back ON. The tire screech sound must be present when the trainer is initially turned ON.

Step 14. Determine if the altitude card (J19) is the original circuit board or the new one. Diagrams 13-1 and 13-2 denote the difference in the AR3 op-amp circuit for the two boards.

For the new card, set the aircraft off the ground. (The altitude of the aircraft can be manually controlled by the pushbutton switches on the outside edge of the altitude card. The blue and green buttons, respectively, increase and decrease the altitude as indicated on the altimeter. To freeze a particular altitude, place the toggle switch above the pushbuttons in a downward position.) Adjust the following with the aircraft at 100 feet altitude and a zero indicated rate of climb (0 VDC at TP2).

At	Adjust	For	System Diagram
J19-TP3	Pot R71 (toggle switch should be down)	zero drift on altimeter	13-2
J19-TP3	Pot R72 (toggle switch should be up)	zero drift on altimeter	13-2

For the old card, set the aircraft at 100 feet and a zero indicated rate of climb, as per instructions above.

At	Adjust	For	System Diagram
J19-TP3	Pot R71 (toggle switch should be up)	zero drift on altimeter	13-1

Step 15. Return the aircraft to ground level

Step 16. Determine if the attitude card (J22) is the original card (633745E) or the new card (B633745E). Diagram 17 denotes the additional potentiometers on the "B" card. Energize the pitch motion system. Fly the GAT-1 to 300' and level off. Obtain a cruise airspeed (115 MPH, 2600 RPM). Switch pitch motion OFF at pitch angle holding zero vertical speed (J19-43). May need to adjust trim tab to maintain zero vertical speed. Check for zero rudder deflection into J22-16; zero side slip angle into J22-15; zero rough air input into J22-13 and 14; zero bank angle at J22-30; and zero VDC at TP-13. Turn the yaw motion switch ON. For both cards, adjust the following:

At	Adjust	For	System Diagram
J22-TP6	Pot R110	zero rate of turn	17

For the B Card, Adjust the following

At	Adjust	For	System Diagram
J22-TP10	Pot R57 (if the physical motion of the yaw system is operational)	zero trainer rotation	17

Energize all motion systems. Fly trainer in a level turn, bank angle 15° (Needle at doghouse).

At	Adjust	For	System Diagram
	Pot R112 (CW to increase turning rate)	Turn Rate of 360° two minutes (3°/sec)	17 17

Step 17. Put the GAT-1 on the ground and turn the motion systems OFF.

Step 18. Place the toggle switches on the X-Y Aircraft Card in a upward position. With zero aircraft velocity (J20-12) and zero wind velocity (J6-39) adjust the following:

At	Adjust	For	System Diagram
J6-43 or TP1	Pot R8	zero drift of aircraft location Y axis	22-2
J6-19 or TP2	Pot R16	zero drift of aircraft location on X axis	22-2

Step 19. Turn the X-Y recorder ON. Place the mode switch on NORM.

Step 20. Slew the aircraft via the N-S, E-W switches on the recorder to 0 VDC on the E-W axis (J6-19) and on the N-S axis (J6-43). If the recorder pen does not go to the recorder center, mechanically adjust the drives.

Step 21. Slew the aircraft on the E-axis until the voltage at J6-19 or TP2 is +5 VDC. If the pen on the recorder has not traveled 3.75 inches from the center on the E-axis, adjust R8 on the E-W servo amplifier (system Diagram 23-2) until the pen does travel to this point.

Step 22. Slew the aircraft on the N-axis until the voltage at J6-43 or TP1 is +5 VDC. Following same procedure as above, except adjust R8 on the N-S servo amplifier, if necessary.

Step 23. Put the toggle switches on the X-Y Aircraft Card in a downward position.

Step 24. Adjust the following:

At	Adjust	For	System Diagram
J16-34	Pot R9	2V P/P	8-2
	Pot R25	agreement of engine sound and RPM	8-2

Step 25. Check and adjust the five 400 Hz sine/cosine inverter cards (System Diagram 36). These cards are located on the VOR/ILS (J9), Glide Slope (J8), and ADF (J5) cards. Adjust each sine/cosine inverter card in the A1 slot (top) of the VOR/ILS card (J9).

1. Tune in any VOR station.
2. Sync scope on J7-TP9, fifth TP from the top.
3. A trace on J7-TP11, third TP from the top.
4. B trace on J9-TP10 (scope input set at high gain for best sensitivity).
5. AC digital voltmeter on J9-TP10.
6. Adjust the gain (middle pot, R9) to obtain 2.5 vac RMS (7.07 v P/P) at TP10; adjust phase (bottom pot, R14) so the zero crossing of the sine wave and square wave occur within 2 μ sec. of each other, adjust the balance (top pot, R15) so the plus and minus zero crossing of the sine wave occur at the zero crossing of the square wave. Alternate all three pot adjustments to obtain these results as some interactions may occur.
7. Interchange sine/cosine inverter cards and check next card placed in the A1 slot.

NOTE: The A1 slot is used because A1-D and J are grounded and typically A1-F input is close to -10 VDC and A2-A input is 0 VDC. If the magnetic deviation on the VOR/ILS Programming Module has been set for other voltages, these will need to be changed so that the cosine value is -10 VDC and sine value is 0 VDC.

Step 26. To check the VOR/ILS Navigational Systems use Table 9-II from the section entitled Navigational Area Programming Panels. Select each station with Navigational Tuning Heads, the knob on the right panel of the MARK-12, and check the Morse code identification calls. Be sure the volume has been turned up and the IDENT button pulled out.

Step 27. Check the VOR/ILS station location voltages and adjust, if necessary. [Use the X- and Y-location plugs on the Voltage Monitoring Panel. The station being checked must be tuned in on the MARK-12 panel. Adjustments are made on the VOR/ILS Programming Module.]

Step 28. Check the magnetic variation voltage and adjust, if necessary. [Use the ILS-sine and ILS-cosine plugs on the Voltage Monitoring Panel. A VOR station must be tuned in on the MARK-12 panel. Adjustments are made on the VOR/ILS Programming Module.]

Step 29. Select a VOR station on the Navigational Tuning Head. Slew the aircraft within range of the station via the switches on the X-Y recorder. Set the OMNI bearing selector (outer dial of the VOA-9 indicator) to 0°. The course deviation needle should indicate the correct direction to fly to the station with an aircraft heading of North which has been indicated on the OMNI bearing selector. The actual heading indication of the directional gyro is irrelevant. The TO-OFF-FROM flag should indicate TO when flying toward a station, FROM when flying from a station; and OFF when abreast of a station.

Step 30. Slew the aircraft to other locations, particularly North, South, East, and West. Check the course deviation needle and the TO-OFF-FROM flag.

Step 31. Repeat Steps 29 and 30 for each VOR station.

Step 32. Slew the aircraft on a VOR station. Turn on the DME. Adjust DME pot in the nose of the aircraft to read zero volts. [Should check X-Y aircraft location and X-Y station location voltages to see if aircraft is actually at station.]

Step 33. Select an ILS station on the Navigational Tuning Head. Slew the aircraft so that it is on an approach path to the appropriate runway. The OMNI bearing selector should not be functional. When in range of the navigational system, the course deviation needle should indicate the correct direction to fly to the station. The TO-OFF-FROM flag should read TO station, the glide slope indicator should show a fly-up condition, and the glide slope OFF flag should disappear.

Step 34. Slew the GAT along the approach pathway. The course deviation needle should reflect proper course deviations and the glide slope indicator should always read fly-up. Approximately at 6 nautical miles the outer marker should become active and the middle marker at 2.26 nautical miles. When the station is passed, the glide slope OFF flag should appear and the glide slope indicator should center.

Step 35. Repeat Steps 33 and 34 for the other ILS station.

Step 36. Position aircraft on the approach pathway just before the OFF flag on the glide slope comes into view.

Step 37. Adjust the balance pot (top) on the modulator on the glide slope card (J8) until the glide slope needle is approximately centered. [To accurately check the glide slope system, the trainer should be flown to see if the glide slope brings the pilot down at approximately the right place on the runway.]

Step 38. Check the frequency and Morse code identification call of each ADF station. [Turn the ADF-31 panel to REC and the volume knob counterclockwise.] The tuning meter should show a maximum deflection. If not, adjust the station frequency potentiometer on the NDB Programming Module.

Step 39. Set the OFF-REC-ADF switch in the REC position. The ADF bearing indicator should be inoperative and the press-to-test button ineffective.

Step 40. With the OFF-REC-ADF switch in the ADF position, press the push-to-test button on the ADF panel. The ADF indicator should rotate approximately 120 degrees counterclockwise.

Step 41. Set the aircraft heading to 180°. Use the procedures in Step 11 to change the directional gyro indication. Turn off the yaw servo system. Reset airspeed to zero. Place toggle switch in upward position.

Step 42. Tune in an ADF station. Slew the aircraft due North of the station. Set the radio compass to 180°. The ADF indicator should be in a true vertical position with the needle pointing to 180°. If it does not, change the synchro in the ADF head. [Be sure to account for the magnetic deviation of the programmed area.]

Step 43. Slew the aircraft to other locations. The ADF indicator should point in the direction of the tuned station. When passing over station, the indicator should swing 180°.

Step 44. Repeat Steps 42 and 43 for each ADF station.

Step 45. Turn off the motion systems. Turn GAT-1 electrical power OFF.

Step 46. Check the GAT-1 Operation and Maintenance Manual, Section IV, for lubrication and mechanical adjustments of the trainer.

VII. FLIGHT CHECK

Card bin should be exposed and the motion switches activated.

A. TAKEOFF AND CLIMB

Prior to takeoff, ensure that the instructor's CG control is set to 25%, Gross WT to 1600 lbs, and OUTSIDE AIR TEMP to STD. Check to see if the nose of the aircraft is in the bottom quarter of the center screens. With the trainer PARKING BRAKE set, the elevator trim wheel in its neutral position, and the FLAPS switch UP, apply full power with the throttle. The tachometer reading should increase to 2450 (±125) rpm. Reduce the setting of the throttle until the tachometer indicates 1800 rpm. Turn the ignition switch from the BOTH position to the R (right) position. The tachometer reading should drop to 1700 (±3) rpm. Next, pulling the carburetor heat control out should cause the tachometer reading to drop to 1650 (±5) rpm. After completing the mag-drop check, return the ignition switch to the BOTH position, and turn the carburetor heat off. Release the PARKING BRAKE and observe the airspeed indicator. When the indicator reaches a ground speed of 70 mph, steady back pressure on the control wheel will cause the trainer to become airborne. The time between the release of the PARKING BRAKE and the trainer reaching an airspeed of 70 mph should be 16 (±3) seconds.

Motion in the pitch axis should become active prior to takeoff, and the trainer should assume a nose-up attitude as indicated on the attitude gyro. The rate of climb indicator and altimeter should also indicate that the trainer is climbing. The initial indication on the rate of climb indicator should be 620 (±30) ft/min. The rate of climb should be accompanied by appropriate changes in the altimeter readings.

During takeoff and climb, the ailerons, elevator, and rudder should be used as required to hold a straight flight path. Continue to climb until the trainer reaches a cruising altitude of 5000 feet, and trim out to level flight.

NOTE: Be sure that the repeater gauges on the Supervisor's Console are in agreement with the trainer.

B. LEVEL FLIGHT AND GLIDE

With the trainer properly trimmed at an altitude of 5000 feet and the throttle at full power, the indicated airspeed should be 114 (±11) mph and the tachometer indication should be 2700 (±14) rpm. Reduce the throttle setting until the tachometer indication is 2600 rpm. The indicated airspeed should decrease to 107 (±2) mph.

Fly at 5000 feet and freeze altitude by activating the toggle switch on altitude card J19. Adjust the throttle to obtain an airspeed of 69 mph. The indicated rate of climb should be 580 (±50) ft/min. Return the altitude toggle switch to its original position.

Trim the trainer at an altitude of 5500 feet and an indicated airspeed of 100 mph. Reduce the power to idle and turn the engine off. Permit the trainer to pitch down to maintain its 100 mph speed. At an altitude of 5000 feet, the simulated windmilling propeller should produce an engine rpm of 650 (±32).

C. STALLS

Trim the trainer at 2500 feet with an airspeed of 70 mph. Cut the power and use the elevator to maintain the trainer at 2500 feet. The trainer should stall at an airspeed of 55 (±5) mph. Once the trainer has stalled, release the controls. The trainer will pitch down, pick up airspeed, and can then be restarted. Repeat the same conditions but with full flaps. The trainer should stall at 45 mph.

Increase power and bring the trainer back to an airspeed of 95 mph at an altitude of 2500 feet. Pitch the trainer up fully so that the attitude gyro indicates maximum pitch angle. The trainer should begin to lose airspeed. As the airspeed drops to 70 (±5) mph, the trainer should stall. Release the controls to permit the trainer's nose to pitch down. When the trainer airspeed increases sufficiently, restart the engine, level off, and increase power to obtain an airspeed of approximately 115 mph.

D. COORDINATED TURNS AND SIDESLIP

Trim the trainer at an altitude of 1000 feet and an airspeed of 115 mph. Initiate a turn using the ailerons and maintain zero sideslip by using the rudder. Use elevator and power as required to maintain altitude and airspeed. With a bank angle of 15 degrees, the needle in the rate of turn indicator should be deflected two needle widths (in the "dog house"). With zero sideslip, the ball in the indicator should be centered.

Repeat the coordinated turn at the same altitude, but at a speed of 60 mph. Under these conditions, coordinate the rudder and elevator controls to produce zero sideslip. At this lower speed, a bank angle of 8 (±3) degrees will produce a "dog house" deflection in the rate of turn indicator.

Trim the trainer at 1000 feet and maintain an airspeed of 115 mph. Initiate a standard rate turn, banking as required to keep the ball centered and the turn needle in the "dog house." Permit the trainer to turn through 360 degrees in this attitude, maintaining an airspeed of 115 mph and an altitude of 1000 feet. The time required for a 360-degree turn should be two minutes (±10 seconds). Repeat the 360-degree turn in the opposite direction. It should be accomplished in two minutes (±10 seconds). During the coordinated turns, the directional gyro should rotate smoothly throughout the turn and return to its original reading at the end of the turn.

To check the sideslip characteristics of the trainer, trim the trainer straight and level at an altitude of 500 feet. The toggle switch on the altitude card (J19) should be actuated to freeze this altitude setting. Adjust the throttle to obtain an airspeed of 105 mph and apply full left rudder. Right aileron pressure should be applied to hold the wings level (zero bank angle). Observe that the turn needle is in the left "dog house" and that the ball is deflected approximately three-quarters ball width to the right. Accomplish these procedures using full right rudder and left aileron pressure to observe right needle deflection ("dog house") and left ball deflection (three-quarters ball width). After completion of these checks, return the toggle switch on the altitude card to its original position.

E. LANDING

After completing the preceding flight and engine tests, the trainer landing should be made at an approach angle suitable for a light aircraft, and with full flaps and medium power setting. Land the trainer and come to a complete stop. Pull on the PARKING BRAKE for zero airspeed. Set the FLAPS switch UP.

F. RECORDER TRACING CHECKOUT

Position the cross-country map on the recorder surface to check out tracking. Tracking is affected by trainer heading and speed during a simulated flight as well as the wind direction and velocity control settings. Two facts about the trainer and recorder which should be remembered when tracking the flight path: the airspeed indicated in the trainer is different from the ground speed which the recorder plots; recorder maps are scaled in nautical miles rather than statute miles.

Set the WIND VELOCITY and DIRECTION controls for a wind of 35 knots blowing due south. Fly the trainer at a speed of 70 knots (approximately 80 mph) at an altitude of 1000 feet. Fly the trainer due east (i.e., trainer

heading of 090 degrees). For the specified conditions of velocity, heading, and wind, the recorder will track on a course which is considerably south of the trainer heading; that is, the recorder trace will indicate a composite heading between 090 and 180 degrees.

After observing the effects of the wind acting at right angles to the trainer heading, fly the trainer on a course of 180 degrees at 70 knots. The wind and trainer are now acting along the same heading. Record the time necessary for the recorder to trace a given distance along this path. Next, reverse the trainer heading, and fly on a heading of 000 degrees at 70 knots. The time required for the trainer to fly the same distance against the wind will be considerably longer.

Next, compare the time required to fly a certain distance with the trainer flying on course 090 degrees and on course 270 degrees. The time required to fly a given distance should be approximately the same in both instances, and the resulting tracings will each be deflected south of the indicated trainer heading.

Finally, check communications between the recorder and the cockpit by utilizing the microphone and headphones provided.

PROJECTION SUBSYSTEM

I. PROJECTION SCREEN

The screen for the VDS system is fabricated from 14 pairs of 1.21 x 1.21 meter (40 x 40 inches) Ektalite screens which have aluminum foil reflecting surfaces cemented to a molded spherical support. The screens are mounted in an array of two high by fourteen wide. Horizontal and vertical cuts were made of the preformed Ektalite screens so as to allow them to abut and form a section of a sphere of 4.57 meters (15 ft.) radius. The resulting lateral dimensions of the upper screens are 100.84 cm. (39.7 in.) at the top and 101.09 cm. (39.8 in.) at the bottom, and the lower screens are 101.09 cm. (39.8 in.) at the top and 97.08 cm. (38.2 in.) at the bottom. The equator of the sphere is .54° below the center line of the upper screens. The joint between the upper and lower screens fall below the horizon of the design eye position. See Figure 11-1. The composite screen extends 176° in azimuth and 25° in elevation with respect to its focal point. Aluminum fixtures are attached to the back of each screen for holding them to each other and to the screen support structure.

The aluminum surface of the Ektalite screen is quite delicate. It is of paramount importance to prevent dirt accumulation on the screen. Particles that collect on the screen can damage the surface, and dust accumulation will degrade the projected images. Cleaning procedures for the screen are presented in Section XII, entitled Maintenance Procedures.

II. SCREEN SUPPORT STRUCTURE

This structure consists of columns, beams, hoops and staves. See Figure 11-2. There are nine columns set at intervals of 25.1° on the arc of a circle. Base plates are welded to the columns and bolted to the floor. Three short sections of aluminum beams are attached to each of the columns. The depths of the beams correspond to the variation in the radius of the sphere with latitude as projected in the horizontal plane. Hoops are fastened to the beams, with each hoop spanning three columns. The hoops are rolled to a cylindrical surface with the elements vertical. Staves are attached to the hoops spaced by the width of each screen panel. The staves are also rolled to a cylindrical surface, but with the elements horizontal. At the equator, the tangent planes to staves are vertical as are the elements of the middle hoop which is set at the equatorial plane of the sphere. The upper and lower ends of the staves are bent into veritcal planes to facilitate attachment to the hoops. The screens are held to the staves along their vertical edges and to each other along the horizontal cut by fasteners attached to the back of the screen. For research purposes, the screens are labeled one through fourteen, with number one on the left side when facing the reflective surface.

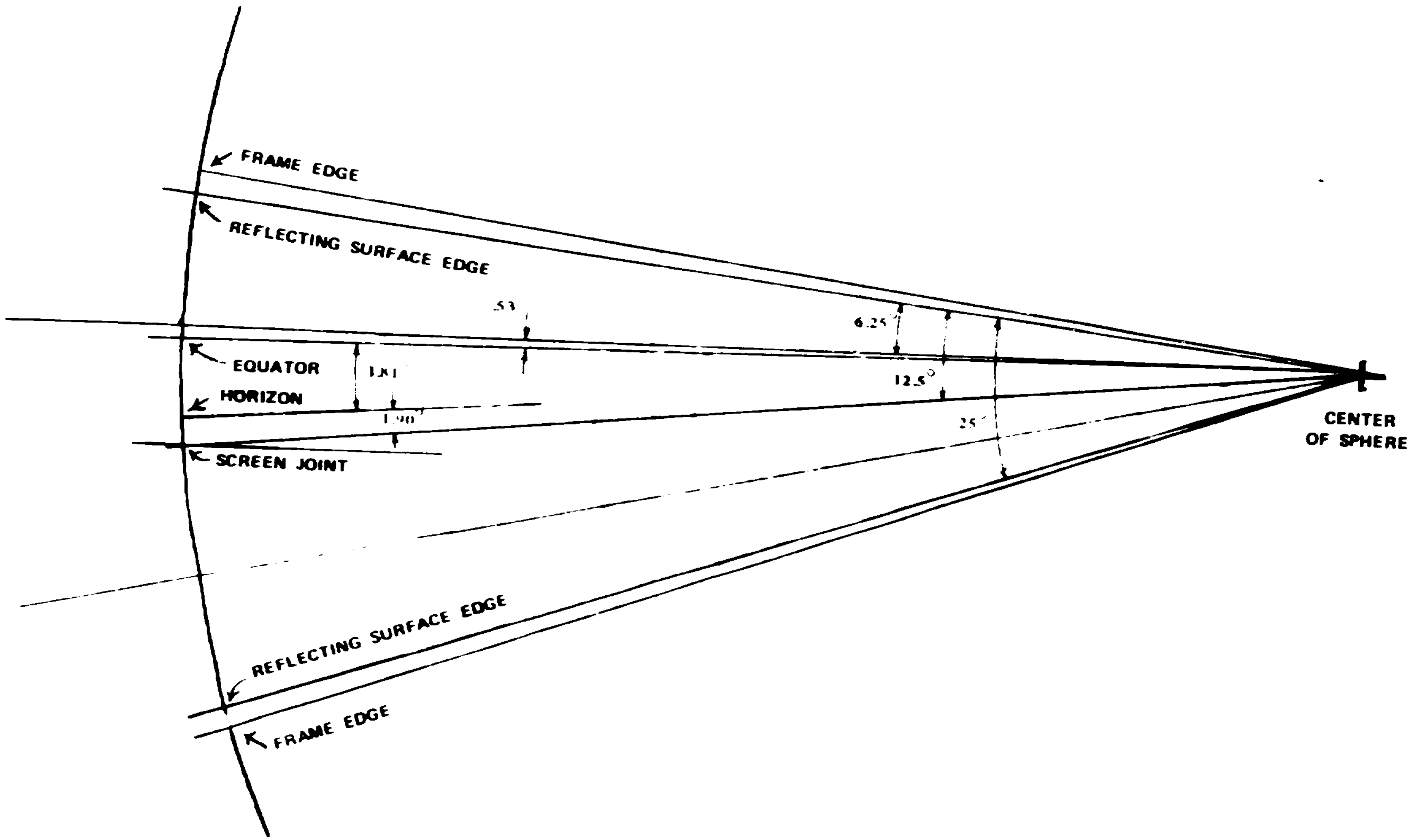


Figure 11 1. Elevation View of Section of Spherical Screen

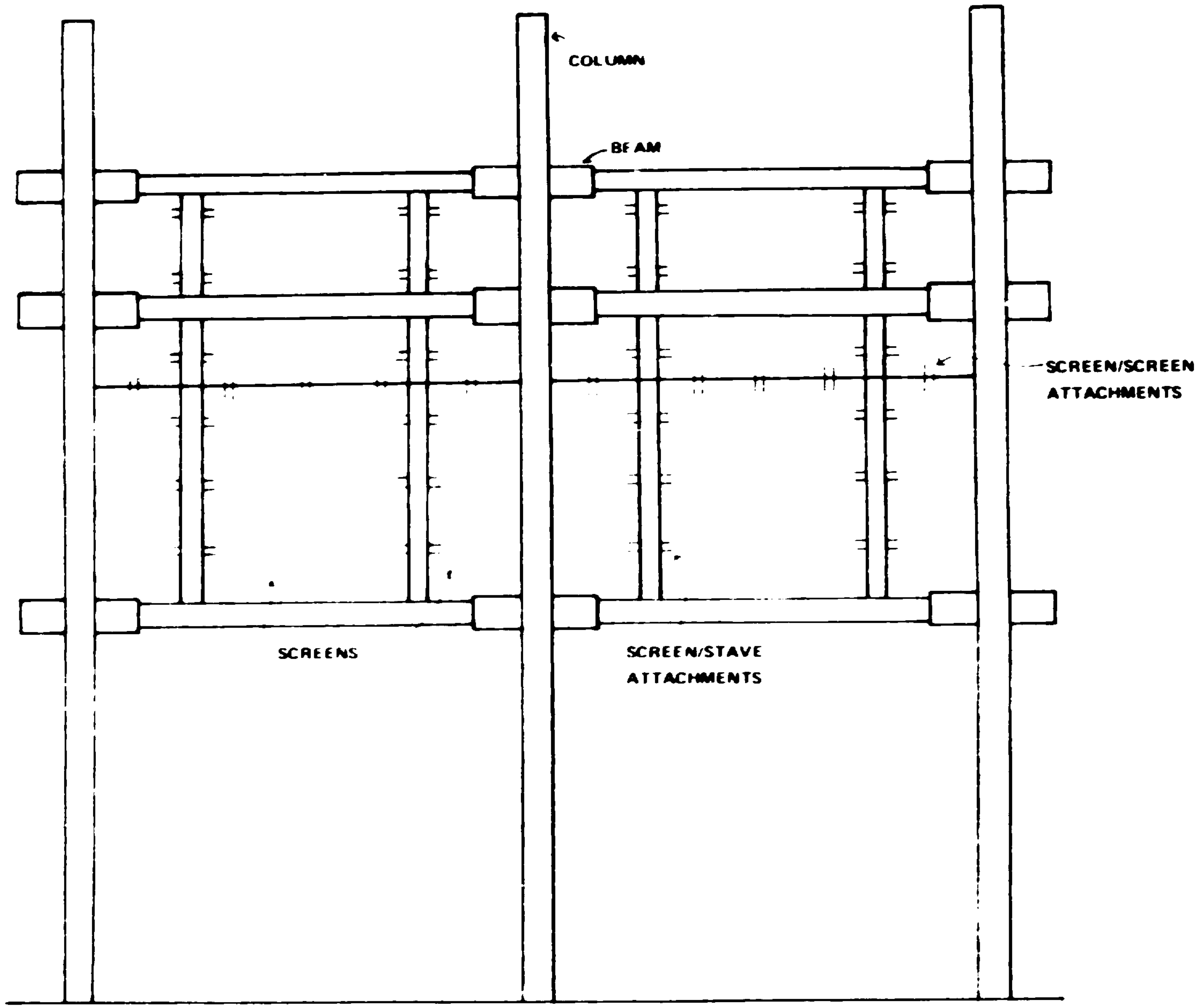


Figure 11.2. Screen Support Structure: Rear View

III. PROJECTION BOOTH

The projection booth is a wood frame, plywood construction, mounted on eight pairs of steel pipe columns. The columns are arranged at intervals of 24° on two concentric circles. The outer columns support the floor of the booth; the inner columns support both the floor of the booth and the projectors. Girders are welded and stiffened by gussets to the columns for supporting the plywood flooring. The girders are sized so that the weight of a person aligning the projectors will not produce a significant rotation of the projectors. Plates which are gusseted are bolted to the floor for vertical support.

Projectors rest on a supporting structure attached to plates welded on top of the inner columns. The supporting structure inclines the axes of the projector lenses downward so that the projected horizon is approximately at eye level. This structure consists of a pair of rails, a pair of plate support angles, and a projector plate for each set of four projectors. Slots are provided in the projector mounting plate so that the projector to screen distance can be varied to correct for tolerance in the focal length of the projection lenses.

Light in the booth is provided by seven fluorescent lights. A dedicated air-conditioning system is required to regulate the temperature in the booth to reduce the heat produced by the projectors. The air flow is first filtered and then forced into the booth. An exhaust fan pulls the air from the booth at a rate which maintains higher pressure inside the booth than outside. SPST thermally activated switches are wired to the power contactor for the projector/dissolve unit receptacles. When the temperature in the booth exceeds the thermostatic setting, the power is automatically cut off.

IV. PROJECTION GEOMETRY

Figure 11-3 gives the projection geometry of the VDS in an elevation view. The center of the spherical screen segment is at O, and the eye of the observer is at point E, a distance of 30.48 centimeters (1 ft.) below O. The film plane of the projector is at the point O, which is a horizontal distance a, 3.05 meters (10 ft.), from E and a vertical distance b, 1.34 meters (4.4 ft.), above E. The radius of the screen from O is 4.57 meters (15 ft.). The point O' on the screen is on the equator of the sphere. Point A is the upper limit of the projected field at a 10° angle above the horizon. Point B is the lower limit of the projected field at a 10° angle below the horizon. The distance QH is 7.74 meters (25.4 ft.), the distance QA is 7.62 meters (25 ft.), and the distance QB is 7.7 meters (25.5 ft.). The angle of QAB is 11.8°. The distance EH is 4.57 meters (15 ft.).

The location of the projector gate is about 1.6% closer to the screen than the distance which preserves angles between taking the pictures and projecting them. The width of field of each camera is 12.94° or 1.6% more than the width of each screen. The two were brought into coincidence by placing the pro-

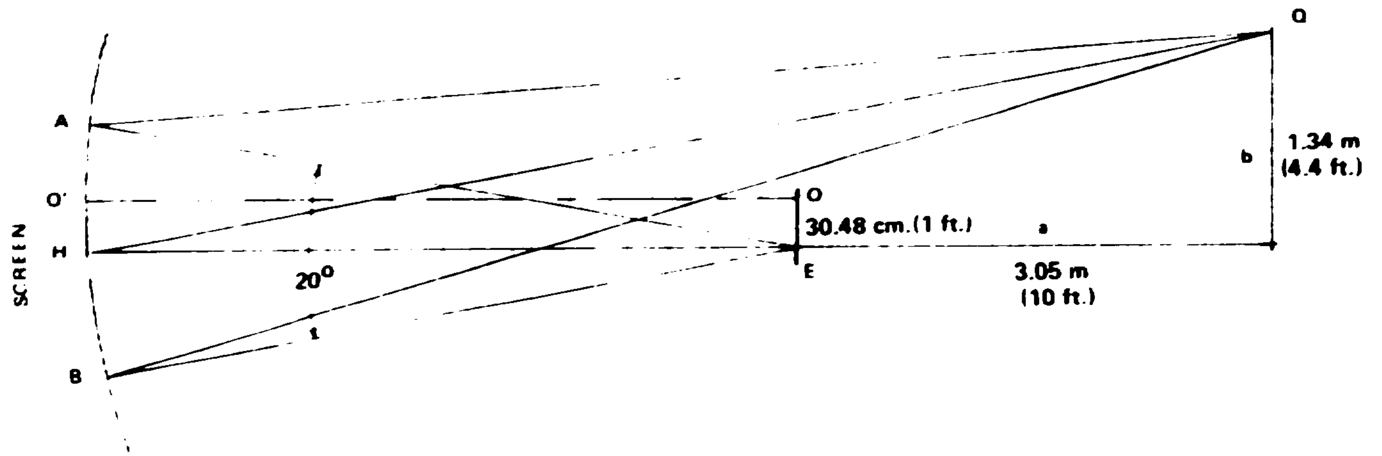


Figure 11-3. Projection Geometry. Elevation View

A. Upper limit of projected image on screen
B. Lower limit of projected image on screen
O. Center of spherical surface
O'. Equator of the sphere
E. Design eye position
H. Horizon of design eye position
Q. Location of projector
a. Horizontal distance between projector and design eye position
b. Vertical distance between projector and design eye position

jectors 1.6% closer which reduces a from 3.05 meters (10 ft.) to 2.93 meters (9.6 ft.). Naturally, slight adjustments are made in this distance to correct for tolerances in the focal length of the projection lenses and camera lenses.

V. VDS Photometric Data. (Data collected April 1973)

All measurements were taken with 7" FL, f:35 Buhl lenses in the projectors. The measures were taken with no slide in the projector gate except when indicated.

A. DIRECTIONALITY OF SCREEN

1. Measurements of directional reflectance for screen SC-7 when illuminated by projector PR-7L on low, empty gate are illustrated in Figure 11-4. These measurements were obtained by displacing a photometer along vertical and horizontal lines which intersect at the focal point of the screen. The direction of the horizontal line was normal to the projection path.

2. Equipment: Luna-Pro with 7.5° FOV.

B. MUTUAL COUPLING

1. With all screens illuminated except the indicated one, the composite mutual couplings are:

Off Screen	Illuminated Screens	Brightness of Illuminated Screens	Luminance of Off Screen Relative	Luminance of Off Screen Absolute
SC-1	All Others	250 Ft.-L	0.032	8.1 Ft.-L
SC-2	↓	↓	0.023	5.7
SC-3			0.020	5.1
SC-4			0.023	5.7
SC-5			0.023	5.7
SC-6			0.020	5.1
SC-7			0.023	5.7
SC-8			0.023	5.7
SC-9			0.020	5.1
SC-10			0.020	5.1
SC-11			0.020	5.1
SC-12			0.026	6.4
SC-13			0.026	6.4
SC-14	↓	↓	0.036	9.1

2. The coupling from screen SC-1 to each of the others is as follows:

a. Screen SC-1 illuminated by projector PR-1L on low, empty gate.

b. All other projectors off.

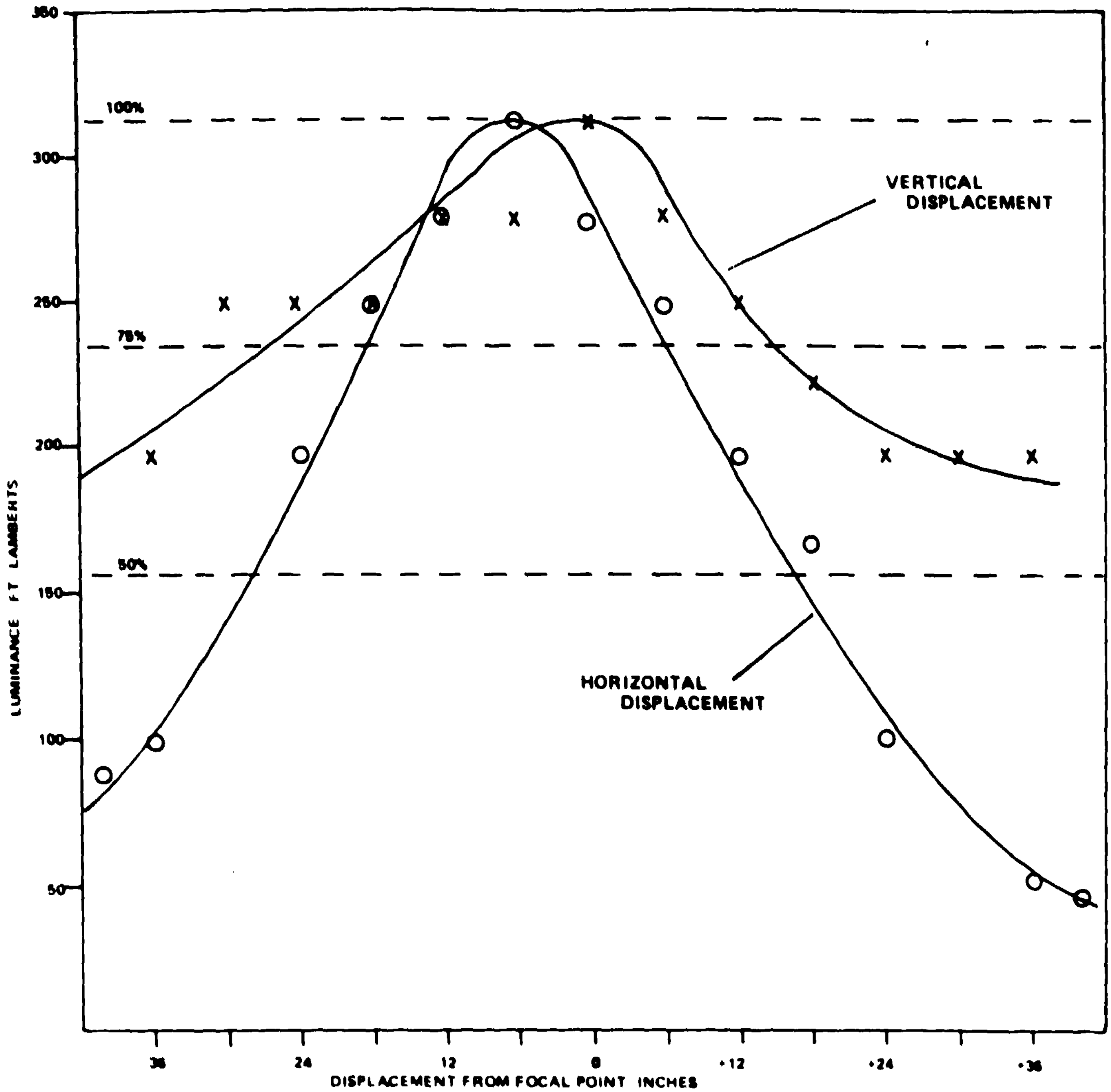


Figure 11-4 Directivity of VDS Projection Screen

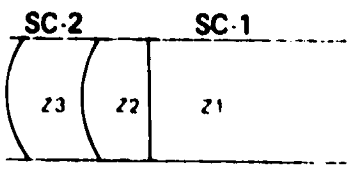
Screen	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Luminance (Ft.L)	250		0.35				0.06					0.18	0.7	3.2
Relative Coupling			$1.4x10^{-3}$				$2.4x10^{-4}$					$7.2x10^{-4}$	$2.8x10^{-3}$	0.013

Smooth Functional Behavior

C. FLARE

1. Screen SC-1 illuminated by PR-1L on low, empty gate.

2. Zone 2 and Zone 3 screen SC-2 illuminated by PR-1L lense flare.



Zone	Z1	Z2	Z3
Luminance (Ft.L)	250	1.6	2.5
Relative	1	.0063	0.01

D. SCREEN LUMINANCE

1. Screen luminance for all projectors with empty gate.

   - Lowest measure with projectors "low" . . . . . . 232 Ft.L
   - Highest measure with projectors "low" . . . . . . 328 Ft.L
   - Lowest measure with projectors "high" . . . . . . 328 Ft.L
   - Highest measure with projectors "high" . . . . . . 500 Ft.L

2. Apparent gain of screen.

   - Typically, with an illumination of 32 Ft.-C, the luminance is 328 Ft.L.
   - With this illumination and a lambertian screen, the luminance would be 32 Ft.L.
   - The apparent gain averages about 10.

3. Screen luminance with slides in projector gate.

   - Three slides with different scenes were selected. One had a water background, one had a land background, and one was over the clouds.
   - The luminance for upper half of the projected images range from 30 Ft.L to 52 Ft.L.
   - The luminance for lower half of projected images ranges from 14 Ft.L to 68 Ft.L.

E. UNIFORMITY OF LUMINANCE OVER SINGLE SCREEN

1. Projector lens was a 7" FL, f3:5 Buhl lens.

2. Projector on low with an empty gate.

   Estimations based on several readings with Luna-Pro (7.5°) and an enlarging meter show a center-to-corner variation of 40 percent in screen luminance due to vignetting in projection lens.

F. RESOLUTION (DATA COLLECTED AUGUST 1976)

1. SC-7 illuminated by PR-7L.

2. Resolution Slide - USAF Resolving Power Test Target.

3. Results indicated that 20 line pairs per millimeter could be identified, which is equivalent to .76 minute visual angle resolution with respect to the design eye position.

VI. PROJECTION EQUIPMENT

Fourteen pairs of Kodak Ektagraphic 35 mm slide projectors with 7" FL, f:3.5 Buhl lenses are used in conjunction with 14 Kodak Dissolve Controls, Model 2, to illuminate each of the 14 contiguous azimuthal screen sectors. Each projector pair consists of an even and odd projector which are mounted on the same plane atop the mounting plate in this projection booth. The even projector is positioned on the right and the odd projector is positioned on the left as viewed in the projection booth facing the screen. Projector pairs 1 through 7 illuminate the right side of projection screen and 8 through 14 illuminate the left side of the projector screen. The slope of the mounting plate inclines the axis of the projector lenses down so that the projected horizon is approximately at eye level. Adjustment screws which are a part of the Ektagraphic projectors are used to adjust the angle of the projectors. Slots are provided in the mounting plate so that the projector-to-screen distance can be varied to correct for tolerances in the focal length of the projector lenses. Once the projectors are aligned, they are secured to the projection mounting plate by the tiedown block cemented to the bottom of each projector.

A dissolve unit drives each projector pair, fading the lamp intensity of one while increasing the intensity of the other in order to maintain essentially constant illumination. The dissolve units are remotely controlled by the PDP 8/e during an experimental run by four control signals (SL ADV LFT, SL ADV RGT, SK EVEN, and SK ODD). SL ADV LFT controls slide advanced of the 7 projector pairs which illuminate the left half of the projection screen. SL ADV RGT controls slide advances of the 7 projector pairs which illuminate the right half of the screen. SK EVEN controls slide skips in the 14 even projectors and SK ODD controls slide skips in the alternate set of the 14 odd projectors. All four signal inputs are provided by relay closures in the Junction Box which toggle a second set of relays in the projection booth.

The dissolve units can also be controlled by a remote control box which connects at the back of the Supervisor's Console. This unit controls the relays in the projection booth which drives the dissolve units. There are five control signals (FWD, REV, SKIP, SL ADV LFT, and SL ADV RGT.) SL ADV RGT and SL ADV LFT controls are the same as above. SKIP controls slide skip in the 14 odd or even projectors. FWD controls the slide advance of all 14 even projectors while REV reverses the slide advance of all 14 "ON" projectors whether odd or even to the previous tray position. For the FWD and REV controls to function properly, the dissolve unit and projectors must be connected so that the bottom remote cord from the dissolve unit is plugged into the even projector.

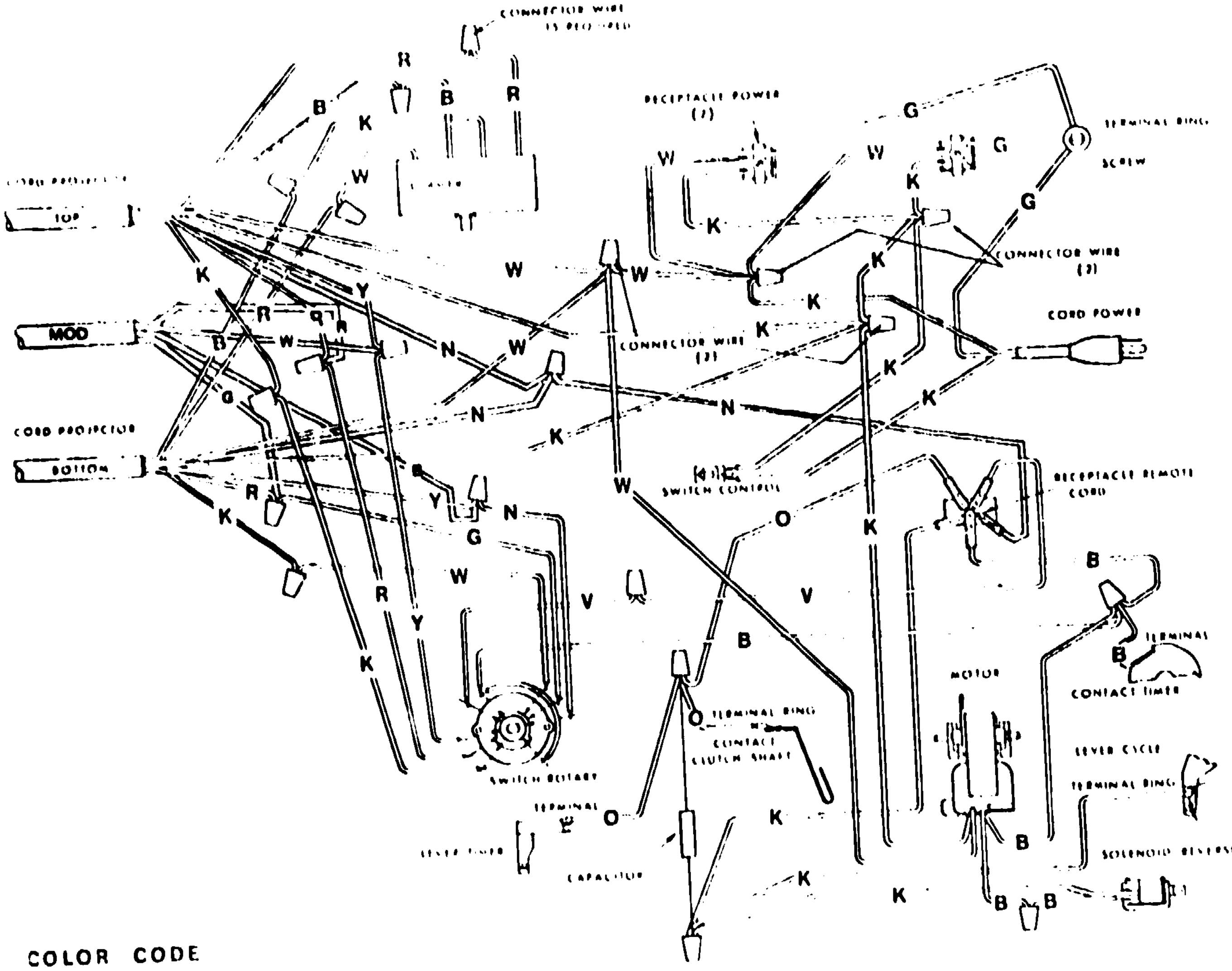
In order for the dissolve units to drive the projectors, the lamp setting of the projectors must be set on FAN and the main switch of the dissolve control unit turned to the ON position. When the three motors are operating (dissolve unit and two projectors), the lamp of one projector should be lit. When an electrical impulse is given to the dissolve unit, the unlit projector changes the slide; e.g., the slide tray moves forward. Simultaneously, the lamp in the "lit" projector fades out and the lamp of the "unlit" projector fades in.

The dissolve unit sequencing affects the manner in which the slides are put in the trays. If the first slide is in the odd tray, slot one, and the second slide is in the even tray, slot one, then the slide presentation must start with both trays set at the starting position and the even projector lamp on. For the VDS, the projector trays have a 180 slide capacity. Under dissolve unit control, 360 slides can be shown in a serial fashion.

All Kodak equipments are standard, off-the-shelf items. However, several minor modifications have been made to the equipment. First, the automatic focus of the projectors has been disconnected. Secondly, aluminum blocks have been attached to the feet of the projectors so that the angle adjustment screws are sensitive to the required changes necessary for alignment. Care should be taken to see that the lateral dimension of the projector is level and that the incline of the optical axis is the same for all projectors for an image to be projected properly on the screen.

As mentioned previously, the dissolve units are controlled by a relay system via the computer or the remote control box. The internal wiring of the dissolve unit was modified for this control. Figure 11-5 depicts the internal wiring of the dissolve unit with the required modification and the computer remote cord receptacle assembly which have been connected to the unit. The wiring of the relay junction box to the dissolve units is shown in Figure 11-6. A 24 VDC power supply is dedicated to the projection relay junction box.

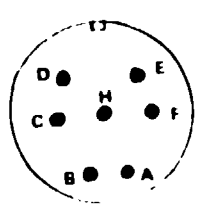
Detailed information concerning the Kodak equipment can be found in the pertinent Kodak literature produced by the manufacturer. This information has been bound together and placed in the VDS facility. Appendix C, Projection System Preparation, gives detailed operating instructions for the VDS projection system.



COLOR CODE

K-BLACK
N-BROWN
R-RED
O-ORANGE
Y-YELLOW
G-GREEN
B-BLUE
V-VIOLET
A-GRAY
W-WHITE

REAR VIEW OF CONNECTOR



SIDE VIEW OF CONNECTOR

PROJECTION BOOTH JUNCTION BOX

Figure 11-5. Dissolve Unit Wiring Schematic with VDS Modification

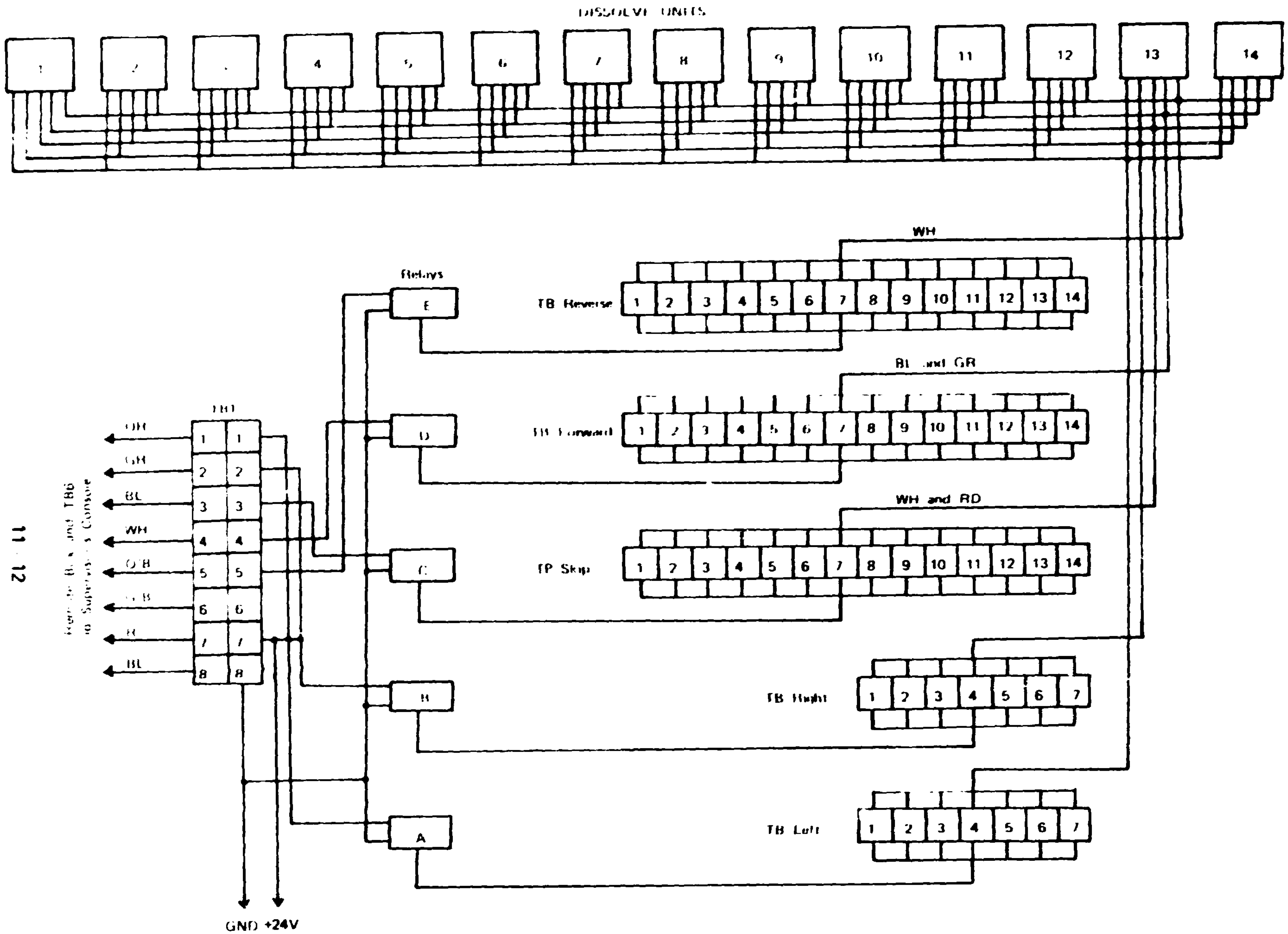


Figure 11-6. Projection Booth Relay Junction Box Wiring Schematic

VII. PHOTOGRAPHIC STIMULI

Photographic stimuli were collected by taking 35 mm slides from a photo aircraft of various radar controlled targets which were vectored to produce a variety of intercepts at different relative headings, relative altitudes, and airspeeds, and several different landing approaches. Seven single lens reflex Nikon cameras with Soligor 105 mm f/2.8 lens were mounted on a vibration isolated platform in the nose section of a Piper Aztec, a twin engine propeller aircraft. The cameras were mounted in the left half of the aircraft's nose with the longer dimension of the transparency vertical so that a photographic field of view of 90° in azimuth by 20° in elevation was covered. Bulk backs, loaded with 33 feet of Kodachrome II film, with an ASA 25 film speed were employed in order to film several intercepts without landing to change film in the cameras. During filming, the cameras were automatically operated in unison every 10 seconds except for a few photographic runs which used a 20-second interval.

Typically, the target plane was either a Musketeer or a Beachcraft aircraft. Occasionally, other aircraft entered the filming area and were also photographed. The radar controlled intercepts of the Musketeer or Beachcraft had a specific flight plan while other aircraft were considered targets of opportunity. The flight plans of the controlled intercepts can be found in Report No. CDC-JL-3 entitled Phase II Photographic Flight Plan. This document, located in the VDS facility, illustrates the collision geometry for each radar controlled intercept overlayed on a map background.

Within any 33-foot roll of film, several different intercepts were photographed. These various intercepts are referred to as runs. Most of the runs were done more than once. Each of the 33-foot rolls of film taken from the seven aircraft cameras represent collectively a set. A set, therefore, has several runs depicted within it.

Slides were formed from the rolls of film by cementing each transparency to an individual slide glass which produced precise slide registration in the projector gate. The edges and corners of the slide glass were ground
the slides from jamming in the projectors and to get adequate registrations. Because of the variation in the thickness of the slide glass, which had a visible effect on the sharpness of the projected image, the slide glass was separated according to thickness. All transparencies projected by a given projector were mounted on the same thickness of glass. The unexposed edge of the film was used to define the edge of the projected image in order to produce sharp edges and the appropriate shape. Because of the projection geometry and spherical screen, the typical rectangular image projects a trapezoidal figure with the sides slightly curved which overlaps into the contiguous fields. This was corrected by placing a thin beryllium copper sheet with the appropriate tapered aperture in the focal plane of the 35 mm cameras. Although the edge of the film on the slide glass defined the edge of the field, an aluminum mask was placed between the edge of the exposed area of the film and the inner edge of the perforations in order to eliminate light passing through the perforations and beyond the edges of the film.

Since the photograph runs filmed only a 90° field of view, half of the slides within a run were reversed when mounted in order to project on the right half of the screen producing a 180° field in azimuth. Slides to be projected on the right half of the screen were mounted with the emulsion side away from the slide glass; whereas, slides to be projected on the left half of the screen were mounted with the emulsion side of the transparency against the slide glass. The photographic landing approach runs were mounted for only a 90° field since the altitude disparity was too great between the first and second half of a run.

The aluminum masks are stamped with a six digit number which uniquely identifies each slide. The first two digits of the slide number refers to the set from which the slide was taken. The third digit refers to the aircraft camera which took that particular slide. The fourth digit indicates whether the slide is mounted to be projected on the left or right side of the screen, whether the slide was taken from the first half of a particular run or the second half, or if the slide is part of an approach sequence. Table 11-1 lists the specific numerical values and their meaning for the fourth digit. The last two digits of the slide number refer to the slide sequence number for that particular set. Information relative to which run the slide came from can only be determined by going to the set documentation where run information and slide sequence numbers are noted.

TABLE II-I

Left Side	Right Side	Digit Meaning
2	0	First half of run
4	6	Last half of run
8	9	Approach sequence

It should be noted that the camera number need not correspond to the slide projector number. This is due to the positioning of the aircraft cameras to avoid photographic interference from the propellor on the left wing. The aircraft cameras at the aft portion of the nose section were positioned to take shots more forward; whereas, the cameras in the midsection were aimed more aft. Slides taken from

cameras 1, 2, 3, 4, 5, 6, and 7 correspond to projector pairs 7, 6, 1, 2, 5, 4, and 3, respectively, for the left side of the projected field and 8, 9, 14, 13, 10, 11, and 12 for the right side of the projected field.

Slides within an individual tray must be mounted for the same projected area. Since the emulsion side of the film is on a different plane, for the right and left projected half of the field, resolution between the two differs. In addition, the film was mounted to a particular reference edge which was not changed when reversing the mounting of the slides. As a result, the film is not positioned in the same area for the two halves, which affects the position of the projected image.

A. Set Documentation

The following pages contain the set documentation which identifies each slide. These data show the number of slides mounted for the right and left side of each run, the run number, and the slide sequence numbers of each run. Occasionally, the run could not be equally divided between the left and right side mounting. This is denoted as a single odd frame. The run ID number with the exception of the last digit corresponds to the intercepts documented in Report No. CDC JL 3, Phase II Photographic Flight Plan. Most of the photographic runs were done more than once. The last digit of the run ID number indicates if this run was the first or second, etc. photographic flight.

Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Last of Sequence	Single Odd Frame	Run ID Number	Comments
R	22	02 ( ) 001	02 ( ) 022		C-1A1	
L	22	02 ( ) 201	02 ( ) 222			
R	8	02 ( ) 023	02 ( ) 030		I 1A1	
L	8	02 ( ) 223	02 ( ) 230			
L	1			02 ( ) 230*		
R	6	02 ( ) 031	02 ( ) 036		O-1A1	
L	6	02 ( ) 231	02 ( ) 236			
R	13	02 ( ) 037	02 ( ) 050		C-[illegible]A2	
L	13	02 ( ) 237	02 ( ) 250			

SET 3

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	26	03 ( ) 601	03 ( ) 626		E-1A1	
L	26	03 ( ) 401	03 ( ) 426			
R	11	03 ( ) 001	03 ( ) 011			
[illegible]	11	03 ( ) 201	03 ( ) 211		G 1A1	
L	1			03 ( ) 211*		
R	7	03 ( ) 627	03 ( ) 633		K 1A1	
[illegible]	7	03 ( ) 427	03 ( ) 433			
[illegible]	7	03 ( ) 634	03 ( ) 640			
L	7	03 ( ) 434	03 ( ) 440		M 1A1	
R	1			03 ( ) 640*		
[illegible]	26	03 ( ) 012	03 ( ) 037			
[illegible]	26	03 ( ) 212	03 ( ) 237		I 1A2	
[illegible]	1			03 ( ) [illegible]*		
[illegible]	8	03 ( ) 641	03 ( ) 648		G 1A2	
[illegible]	8	03 ( ) 441	03 ( ) 448			
R	8	03 ( ) 038	03 ( ) 045		K 1A2	
[illegible]	8	03 ( ) 238	03 ( ) 245			
[illegible]	1			03 ( ) 245*		
[illegible]	[illegible]	03 ( ) 801	03 ( ) 846			NAFEC Approach

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	58	04 ( ) 601	04 ( ) 658		R 1A1	This set was not mounted.
L	58	04 ( ) 401	04 ( ) 458			
R	8	04 ( ) 001	04 ( ) 008			
L	8	04 ( ) 201	04 ( ) 208		L 1A1	
L	1			04 ( ) 208*		

SET 5

[illegible]	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	8	05 ( ) 601	05 ( ) 608		H IA1	
L	8	05 ( ) 401	05 ( ) 408			
R	8	05 ( ) 001	05 ( ) 008			
[illegible]	8	05 ( ) 201	05 ( ) 208		H IA2	
[illegible]	1			05 ( ) 208*		
[illegible]	[illegible]	[illegible] 009	05 ( ) 017		[illegible] IA1	
[illegible]	[illegible]	05 ( ) 209	05 ( ) [illegible]			
R	[illegible]	05 ( ) 609	05 ( ) 618		[illegible] IA2	
L	[illegible]	05 ( ) 409	05 ( ) 418			
[illegible]	[illegible]	[illegible] 018	05 ( ) 035			
[illegible]	[illegible]	[illegible] 218	05 ( ) 235		D IA1	
[illegible]	1			05 ( ) 235*		
R	[illegible]	[illegible]	05 ( ) 625			
[illegible]	[illegible]	05 ( ) 419	05 ( ) 425		N IA1	
[illegible]	1			05 ( ) 625*		
[illegible]	[illegible]	[illegible] 036	05 ( ) 042		N IA2	
L	[illegible]	05 ( ) 236	05 ( ) 242			
[illegible]	5	05 ( ) 626	05 ( ) 630		L IA3	
[illegible]	5	05 ( ) 426	05 ( ) 430			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number			Run ID Number	Comments
		First of Sequence	Last of Sequence	Single Odd Frame		
L	9	05 ( ) 043	05 ( ) 051			
L	9	05 ( ) 243	05 ( ) 251		L 1A4	
L	1			05 ( ) 251*		
R	17	05 ( ) 631	05 ( ) 647		D 1A2	
L	17	05 ( ) 431	05 ( ) 447			

SET 6

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	21	06 ( ) 601	06 ( ) 621			
L	21	06 ( ) 401	06 ( ) 421		C 6A1	
R	1			06 ( ) 621*		
R	23	06 ( ) 001	06 ( ) 023			
L	23	06 ( ) 201	06 ( ) 223		E-7A1	
L	1			06 ( ) 223*		
R	9	06 ( ) 024	06 ( ) 032		I 7A1	
L	9	06 ( ) 224	06 ( ) 232			
R	12	06 ( ) 033	06 ( ) 044			
L	12	06 ( ) 233	06 ( ) 244		O 4A1	
L	1			06 ( ) 244*		
R	20	06 ( ) 045	06 ( ) 064			
L	20	06 ( ) 245	06 ( ) 264		C 6A2	
L	1			06 ( ) 264*		
R	8	06 ( ) 622	06 ( ) 629		I 7A2	
L	8	06 ( ) 422	06 ( ) 429			
R	15	06 ( ) 630	06 ( ) 644		C 6A[illegible]	
L	15	06 ( ) 430	06 ( ) 444			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number			Run ID Number	Comments
		First of Sequence	Last of Sequence	Single Odd Frame		
R	10	06 ( ) 645	06 ( ) 654		E 7A2	
L	10	06 ( ) 445	06 ( ) 454			

SET 7

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	9	07 ( ) 601	07 ( ) 609		K 6A1	
L	9	07 ( ) 401	07 ( ) 409			
R	9	07 ( ) 001	07 ( ) 009		K 6A2	
L	9	07 ( ) 201	07 ( ) 209			
R	9	07 ( ) 010	07 ( ) 018			
L	9	07 ( ) 210	07 ( ) 218		L 7A1	
L	1			07 ( ) 218*		
R	8	07 ( ) 610	07 ( ) 617			
L	8	07 ( ) 410	07 ( ) 417		L 7A2	
R	1			07 ( ) 617*		
R	20	07 ( ) 019	07 ( ) 038			
L	20	07 ( ) 219	07 ( ) 238		B 7A1	
L	1			07 ( ) 238*		
R	21	07 ( ) 618	07 ( ) 638			
L	21	07 ( ) 418	07 ( ) 438		B 7A2	
[illegible]	1			07 ( ) 638*		
[illegible]	10	07 ( ) 039	07 ( ) 048		G 7A1	
[illegible]	10	07 ( ) 239	07 ( ) 248			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	10	07 ( ) 639	07 ( ) 648		G 7A2	
L	10	07 ( ) 439	07 ( ) 448			
R	1			07 ( ) 648*		
R	11	07 ( ) 649	07 ( ) 659		H 7A1	
L	11	07 ( ) 449	07 ( ) 459			
R	8	07 ( ) 049	07 ( ) 056		H 7A2	
L	8	07 ( ) 249	07 ( ) 256			

SET 8

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Last of Sequence	Single Odd Frame	Run ID Number	Comments
R	35	08 ( ) 001	08 ( ) 035		C 1A3	This set was not mounted.
L	35	08 ( ) 201	08 ( ) 235			
R	30	08 ( ) 601	08 ( ) 630		C 1A4	
L	30	08 ( ) 401	08 ( ) 430			
L	9	08 ( ) 631	08 ( ) 639			
L	9	08 ( ) 431	08 ( ) 439		N 1A3	
R	1			08 ( ) 649*		
R	9	08 ( ) 036	08 ( ) 044		N 1A4	
L	9	08 ( ) 236	08 ( ) 244			
R	10	08 ( ) 640	08 ( ) 649		O 1A2	
L	10	08 ( ) 440	08 ( ) 449			
R	9	08 ( ) 045	08 ( ) 053		O 1A3	
L	9	08 ( ) 245	08 ( ) 253			
R	12	08 ( ) 650	08 ( ) 661			
[illegible]	12	08 ( ) 450	08 ( ) 461		I 1A3	
[illegible]	1			08 ( ) 661*		
R	7	08 ( ) 054	08 ( ) 060		I 1A4	
L	7	08 ( ) 254	08 ( ) 260			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Last of Sequence	Single Odd Frame	Run ID Number	Comments
R	17	09 ( ) 001	09 ( ) 017			
L	17	09 ( ) 201	09 ( ) 217		F 2A1	
L	1			09 ( ) 217*		
R	7	09 ( ) 601	09 ( ) 607			
L	7	09 ( ) 401	09 ( ) 407		O 4A1	
R	1			09 ( ) 607*		
R	9	09 ( ) 018	09 ( ) 026		O 4A2	
L	9	09 ( ) 218	09 ( ) 226			
R	12	09 ( ) 608	09 ( ) 619		F 1A1	
L	12	09 ( ) 408	09 ( ) 419			
R	9	09 ( ) 027	09 ( ) 035		F 1A2	
L	9	09 ( ) 227	09 ( ) 235			
R	10	09 ( ) 620	09 ( ) 629			
L	10	09 ( ) 420	09 ( ) 429		O 8A1	
R	1			09 ( ) 629*		
R	[illegible]	09 ( ) 036	09 ( ) 042			
L	7	09 ( ) 236	09 ( ) 242		O 8A2	
L	1			09 ( ) 242*		

SET 9 (Cont'd)

[illegible]	Number of Frames in Sequence	Slide Identification Number			Run ID Number	Comments
		First of Sequence	Last of Sequence	Single Odd Frame		
R	11	09 ( ) 630	09 ( ) 640			
L	11	09 ( ) 430	09 ( ) 440		H-1A3	
R	1			09 ( ) 640*		
R	11	09 ( ) 043	09 ( ) 053		H 1A4	
L	11	09 ( ) 243	09 ( ) 253			
R	8	09 ( ) 641	09 ( ) 648			
L	8	09 ( ) 441	09 ( ) 448		H 1A5	
R	1			09 ( ) 648*		
R	9	09 ( ) 649	09 ( ) 657			
L	9	09 ( ) 449	09 ( ) 457		J 7A1	
R	1			09 ( ) 657*		

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	13	10 ( ) 001	10 ( ) 013			
L	13	10 ( ) 201	10 ( ) 213		H-5A1	
L	1			10 ( ) 213*		
R	21	10 ( ) 601	10 ( ) 621		E-2A2	
L	21	10 ( ) 401	10 ( ) 421			
R	26	10 ( ) 014	10 ( ) 039			
L	26	10 ( ) 214	10 ( ) 239		C 6A4	
L	1			10 ( ) 239*		
R	57	10 ( ) 040	10 ( ) 096		A 2A1	
L	57	10 ( ) 240	10 ( ) 296			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	8	11 ( ) 601	11 ( ) 608		K-6A3	
L	8	11 ( ) 401	11 ( ) 408			
R	10	11 ( ) 001	11 ( ) 010		L-7A3	
L	10	11 ( ) 201	11 ( ) 210			
R	10	11 ( ) 609	11 ( ) 618		L 7A4	
L	10	11 ( ) 409	11 ( ) 418			
R	7	11 ( ) 011	11 ( ) 017			
L	7	11 ( ) 211	11 ( ) 217		L 7A5	
L	1			11 ( ) 217*		
R	11	11 ( ) 018	11 ( ) 028		R 4A1	
L	11	11 ( ) 218	11 ( ) 228			
R	10	11 ( ) 029	11 ( ) 038			
L	10	11 ( ) 229	11 ( ) 238		S 5A1	
L	1			11 ( ) 238*		
R	12	11 ( ) 039	11 ( ) 050			
L	12	11 ( ) 239	11 ( ) 250		R 1A1	
L	1			11 ( ) 250*		
R	13	11 ( ) 619	11 ( ) 631		S 1A1	
L	13	11 ( ) 419	11 ( ) 431			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	13	11 ( ) 051	11 ( ) 063			
L	13	11 ( ) 251	11 ( ) 263		S 1A2	
L	1			11 ( ) 263*		
R	9	11 ( ) 064	11 ( ) 072		S 2A1	
L	9	11 ( ) 264	11 ( ) 272			
R	9	11 ( ) 632	11 ( ) 640		R 1A2	
L	9	11 ( ) 432	11 ( ) 440			

SET 12

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	9	12 ( ) 001	12 ( ) 009			
L	9	12 ( ) 201	12 ( ) 209		J 1A3	
L	1			12 ( ) 209*		
R	9	12 ( ) 601	12 ( ) 609			
L	9	12 ( ) 401	12 ( ) 409		N 1A5	
R	1			12 ( ) 609*		
R	16	12 ( ) 010	12 ( ) 025		F 1A3	
L	16	12 ( ) 210	12 ( ) 225			
R	10	12 ( ) 026	12 ( ) 035		H 1A6	
L	10	12 ( ) 226	12 ( ) 235			
R	9	12 ( ) 610	12 ( ) 618			
L	9	12 ( ) 410	12 ( ) 418		O 8A3	
R	1			12 ( ) 618*		
R	9	12 ( ) 036	12 ( ) 044			
L	9	12 ( ) 236	12 ( ) 244		O 8A4	
L	1			12 ( ) 244*		
L	44	12 ( ) 801	12 ( ) 844			NAFEC Approach
[illegible]	30	12 ( ) 901	12 ( ) 930			Bader Approach
R	25	12 ( ) 931	12 ( ) 955			Bader Approach
R	18	12 ( ) 956	12 ( ) 973			Bader Approach

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number			Run ID Number	Comments
		First of Sequence	Last of Sequence	Single Odd Frame		
R	15	13 ( ) 601	13 ( ) 615		F 1A4	
L	15	13 ( ) 401	13 ( ) 415			
R	13	13 ( ) 616	13 ( ) 628		H-1A7	
L	13	13 ( ) 416	13 ( ) 428			
R	11	13 ( ) 629	13 ( ) 639		K-1A3	
L	11	13 ( ) 429	13 ( ) 439			
R	9	13 ( ) 001	13 ( ) 009			
L	9	13 ( ) 201	13 ( ) 209		K 1A4	
L	1			13 ( ) 209*		
R	8	13 ( ) 010	13 ( ) 017			
L	8	13 ( ) 210	13 ( ) 217		N 1A6	
L	1			13 ( ) 217*		
R	7	13 ( ) 642	13 ( ) 648			
L	7	13 ( ) 442	13 ( ) 448		N-1A7	
R	1			13 ( ) 648*		
R	29	13 ( ) 018	13 ( ) 046			
L	29	13 ( ) 218	13 ( ) 246		B 1A3	
L	1			13 ( ) 245*		
R	53	13 ( ) 901	13 ( ) 953			Phila. Approach

SET 14

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	40	14 ( ) 001	14 ( ) 040		B-1A4	
L	40	14 ( ) 201	14 ( ) 240			
R	35	14 ( ) 601	14 ( ) 635			
L	35	14 ( ) 401	14 ( ) 435		B 2A1	
R	1			14 ( ) 635*		
R	21	14 ( ) 041	14 ( ) 061		D 1A3	
L	21	14 ( ) 241	14 ( ) 261			
R	18	14 ( ) 062	14 ( ) 079			
L	18	14 ( ) 262	14 ( ) 279		F 6A1	
L	1			14 ( ) 279*		
R	5	14 ( ) 636	14 ( ) 640		L 1A5	
L	5	14 ( ) 436	14 ( ) 440			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	11	15 ( ) 001	15 ( ) 011		R 1A3	
L	11	15 ( ) 201	15 ( ) 211			
R	11	15 ( ) 601	15 ( ) 611		R 1A4	
L	11	15 ( ) 401	15 ( ) 411			
R	11	15 ( ) 612	15 ( ) 622			
L	11	15 ( ) 412	15 ( ) 422		R 4A2	
R	1			15 ( ) 622*		
R	13	15 ( ) 012	15 ( ) 024		R 1A5	
L	13	15 ( ) 212	15 ( ) 224			
R	16	15 ( ) 623	15 ( ) 638		R 1A6	
L	16	15 ( ) 423	15 ( ) 438			
R	18	15 ( ) 025	15 ( ) 042			
L	18	15 ( ) 225	15 ( ) 242		D 1A4	
L	1			15 ( ) 242*		
R	11	15 ( ) 639	15 ( ) 649			
L	11	15 ( ) 439	15 ( ) 449		L 1A5	
R	1			15 ( ) 649*		

SET 16

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
L	27	16 ( ) 801	16 ( ) 827			NAFEC Approach
L	18	16 ( ) 828	16 ( ) 845			NAFEC Approach
L	17	16 ( ) 846	16 ( ) 862			NAFEC Approach
R	20	16 ( ) 901	16 ( ) 920			Bader Approach
R	8	16 ( ) 001	16 ( ) 008			
L	8	16 ( ) 201	16 ( ) 208		J 7A2	
L	1			16 ( ) 208*		
R	14	16 ( ) 009	16 ( ) 022		L 1A6	
L	14	16 ( ) 209	16 ( ) 222			
R	12	16 ( ) 023	16 ( ) 034		M 1A2	
L	12	16 ( ) 223	16 ( ) 234			
L	27	16 ( ) 863	16 ( ) 889			Millsville Approach
R	48	16 ( ) 921	16 ( ) 968			Phila. Approach
R	9	16 ( ) 969	16 ( ) 977			Phila. Approach

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number			Run ID Number	Comments
		First of Sequence	Last of Sequence	Single Odd Frame		
R	37	17 ( ) 901	17 ( ) 937			Newark Approach
R	21	17 ( ) 938	17 ( ) 976			Caldwell Approach

SET 18

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	58	18 ( ) 601	18 ( ) 658			
L	58	18 ( ) 401	18 ( ) 458		A 2A2	
R	1			18 ( ) 658*		
R	29	18 ( ) 659	18 ( ) 687			
L	29	18 ( ) 459	18 ( ) 487		B 1A5	
R	1			18 ( ) 687*		
R	15	18 ( ) 688	18 ( ) 702		F 7A1	
L	15	18 ( ) 488	18 ( ) 502			
R	9	18 ( ) 001	18 ( ) 009		G 7A3	
L	9	18 ( ) 201	18 ( ) 209			
R	6	18 ( ) 703	18 ( ) 708		M 1A3	
L	6	18 ( ) 503	18 ( ) 508			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	34	19 ( ) 001	19 ( ) 034		B 7A3	
L	34	19 ( ) 201	19 ( ) 234			
R	33	19 ( ) 601	19 ( ) 633		G 1A5	
L	33	19 ( ) 401	19 ( ) 433			
R	1			19 ( ) 633*		
R	9	19 ( ) 035	19 ( ) 043		G 1A4	
L	9	19 ( ) 235	19 ( ) 243			
R	9	19 ( ) 634	19 ( ) 642		G 2A1	
L	9	19 ( ) 434	19 ( ) 442			
R	7	19 ( ) 643	19 ( ) 649		J 1A5	
L	7	19 ( ) 443	19 ( ) 449			
R	5	19 ( ) 044	19 ( ) 048			
L	5	19 ( ) 244	19 ( ) 248		N 1A8	
L	1			19 ( ) 248*		
R	6	19 ( ) 650	19 ( ) 655			
L	6	19 ( ) 450	19 ( ) 455		K 1A7	
R	1			19 ( ) 655*		
R	12	19 ( ) 049	19 ( ) 060		K 1A8	
L	12	19 ( ) 249	19 ( ) 260			

SET 20

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	6	20 ( ) 601	20 ( ) 606			
L	6	20 ( ) 401	20 ( ) 406		O-1A4	
R	1			20 ( ) 606*		
R	7	20 ( ) 607	20 ( ) 613			
L	7	20 ( ) 407	20 ( ) 413		O-4A2	
R	1			20 ( ) 613*		
R	6	20 ( ) 001	20 ( ) 006			
L	6	20 ( ) 201	20 ( ) 206		O-7A1	
R	1			20 ( ) 206*		
R	26	20 ( ) 614	20 ( ) 639			
L	26	20 ( ) 414	20 ( ) 439		E 1A3	
R	1			20 ( ) 639*		
R	11	20 ( ) 007	20 ( ) 017			
L	11	20 ( ) 207	20 ( ) 217		H-1A8	
L	1			20 ( ) 217*		
R	5	20 ( ) 640	20 ( ) 644			
L	5	20 ( ) 440	20 ( ) 444		K-1A9	
R	1			20 ( ) 644*		

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number			Run ID Number	Comments
		First of Sequence	Last of Sequence	Single Odd Frame		
R	10	20 ( ) 018	20 ( ) 027		R 1A7	
L	10	20 ( ) 218	20 ( ) 227			
R	10	20 ( ) 028	20 ( ) 037		R 4A3	
L	10	20 ( ) 228	20 ( ) 237			
L	11	20 ( ) 445	20 ( ) 455		R 1A8	
R	11	20 ( ) 645	20 ( ) 655			
R	9	20 ( ) 656	20 ( ) 664			
L	9	20 ( ) 456	20 ( ) 464		S 1A3	
R	1			20 ( ) 664*		
R	10	20 ( ) 665	20 ( ) 667		S 2A2	
L	10	20 ( ) 465	20 ( ) 467			

SET 21

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number: First of Sequence	Slide Identification Number: Last of Sequence	Slide Identification Number: Single Odd Frame	Run ID Number	Comments
R	38	21 ( ) 901	21 ( ) 938			Ocean City Approach
L	25	21 ( ) 801	21 ( ) 825			Ocean City Approach
R	21	21 ( ) 939	21 ( ) 959			Bader Approach
L	27	21 ( ) 826	21 ( ) 852			Milleville Approach
L	30	21 ( ) 853	21 ( ) 882			Milleville Approach
R	9	21 ( ) 601	21 ( ) 609			
L	9	21 ( ) 401	21 ( ) 409		H-1A9	
R	1			21 ( ) 609*		
R	9	21 ( ) 610	21 ( ) 618			
L	9	21 ( ) 410	21 ( ) 418			
R	10	21 ( ) 001	21 ( ) 010		K 1A10	
L	10	21 ( ) 201	21 ( ) 210			
R	6	21 ( ) 011	21 ( ) 016		M 1A4	
L	6	21 ( ) 211	21 ( ) 216			
R	9	21 ( ) 619	21 ( ) 627		N 1A9	
L	9	21 ( ) 419	21 ( ) 427			

Mount Left or Right	Number of Frames in Sequence	Slide Identification Number			Run ID Number	Comments
		First of Sequence	Last of Sequence	Single Odd Frame		
R	46	22 ( ) 001	22 ( ) 046			
L	46	22 ( ) 201	22 ( ) 246		A 2A3	
L	1			22 ( ) 246*		
R	19	22 ( ) 047	22 ( ) 065		E-1A4	
L	19	22 ( ) 247	22 ( ) 265			
R	7	22 ( ) 066	22 ( ) 072		N 1A10	
L	7	22 ( ) 266	22 ( ) 272			
R	7	22 ( ) 601	22 ( ) 607			
L	7	22 ( ) 401	22 ( ) 407		N 1A11	
R	1			22 ( ) 607*		
R	8	22 ( ) 608	22 ( ) 615		O 4A3	
L	8	22 ( ) 408	22 ( ) 415			
R	7	22 ( ) 073	22 ( ) 079		O 1A4	
L	7	22 ( ) 273	22 ( ) 279			
R	22	22 ( ) 616	22 ( ) 637		D 1A5	
L	22	22 ( ) 416	22 ( ) 437			

B. Target Slides

The following pages denote the slides of each run which have targets. These data are broken down by right or left half of the projected screen with the corresponding camera and screen panel number.

SET 2

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
209						T										Run C--1A1
210						T										
211						T										
212						T										
213						T										
214						T										
215						T	T									
216							T									
217							T									
218							T									
219							T									
224						T										Run I–1A1
225						T										
226							T									
227							T									
228							T									
229							T									
237		T														Run C -1A2
238		T														
239		T														
240			T													
241			T													
242			T													
243			T													
244			T													
245				T												

SET 3																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
201					T											Run G 1A1
202					T											
203					T											
204					T											
205					T											
206					T											
207					T											
208					T											
209					T											
								633						T		Run K 1A1
224			T													Run E 1A2
225			T													
226			T													
228		T														
229		T														
230		T														
231	T															
232	T															
233	T															
234	T															
235	T															
236	T															
237	T															
237*	T															
								641					T			Run G 1A1
								642					T			
								643					T			
								644					T			
								645					T			

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Camera Number / Panel Number
								646				T				Run G 1A1
								647				T				
241					T											Run K 1A2
242					T											
243					T											
244					T											
245					T											
245*				T												
801				T			T									NA AP1
802			T				T									
803			T				T									
804		T					T									
805		T					T									
806	T						T									
807							T									
808							T									
809							T									
810							T									
811						T	T									
812						T	T									
813					T											
814					T											
815					T		T									
816					T		T									
817						T T										
818						T										
819						T	T									
824							T									
825					T											

Table heading: SET 3 (Cont'd)

SET 3 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
826				T												
827			T													
828			T													
829			T													

SET 5																	NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3		Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14		Panel Number
																	This set has not been checked
																	for targets

SET 6

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								608						T		Run C 6A1
								609						T		
								610						T		
								611						T		
								612						T		
								613						T		
								614						T		
								615						T		
								616							T	
								617							T	
								618							T	
								619							T	
								620							T	
								630						T		Run C 6A3
								631						T		
								632						T		
								633						T		
								634					T			
								635					T			
								636						T		
								637						T		
								638						T		
								639						T		
								640						T		
								641						T		
								642						T		
								643						T		

SET 7																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
453						T										Run H-7A1
454					T											
455					T											
456				T												
457				T												
458			T													
459		T														
								001				T				Run K 6A2
								002				T				
								003					T			
								004						T		
								005							T	
								612	T							Run L 7A2
								613	T							
								614		T						
								615		T						
								616				T				
								617						T		
								617*							T	
210							T									Run L 7A1
211							T									
212						T	T									
213					T		T									
214				T			T									
215		T					T									
222					T											Run B 7A1
223					T											
224				T												
225				T												

SET 7 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
226				T												Run B 7A1
227				T												↓

SET 9																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
204			T													Run E 2A1
205			T													
206			T													
207			T													
208			T													
209				T												
210				T												

SET 10																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
221		T														Run C–6A4
222		T														
223		T														
224		T														
225		T														
226		T														
227		T				T										
228		T				T										
229		T			T											
232		T		T												
234		T	T													
235		T/T														
236		T/T														
237	T/T															
238	T/T															
239	T															
285							T									Run A–2A1
286							T									
287							T									
289							T									
								605					T			Run E–2A2
								606					T			
								607					T			
								608					T			
								609					T			
								610					T			

SET 10 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								611					T			Run E 2A2
								612					T			
								613					T			
								614					T			
								615					T			
								616					T			
								617					T			
								618					T			

	SET 11															NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
232						T										Run S 5A1
233						T										
234					T											
235																
236			T													
237			T													
238		T														
268				T												Run S 2A1
269				T												
270																
271		T														
219				T												Run R 4A1
220				T												
221				T												
222				T												
223				T												
224				T												
225		T														
226		T														
227	T															
228	T															
								630						T		Run S [illegible]A1
								631							T	
								611			T					Run [illegible] [illegible]A4
								612		T						
								613				T				
								614					T			
								616						T		

SET 11 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES: Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								617							T	Run L 7A1
203					T											Run L 7A3
204					T											
205					T											
207					T											
208						T										
214							T									Run L 7A5
215							T									
216				T												
217				T												

SET 12																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								037				T				Run O 8[illegible]4
								038				T				
								039					T			
								040					T			
								041					T			
								042					T			
								043					T			
811				T												Run NA AP2
812				T												
813				T												
814				T												
815				T												
816				T												
817				T												
818				T												
819				T												
820				T												
821				T												
822				T												
823				T												
824	T			T												
825	T			T												
826	T			T												
827	T			T												
828	T			T												
829	T			T												
830		T		T												
831	T			T												
832		T		T												

SET 12 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES
																Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
833		T		T												Run NA AP2
834				T												
835				T												
836				T												
837				T												
838					T											
839				T												
								945			T					Run BA AP2
								946			T					
								948				T				
								949				T				
								950			T					
								963				T				Run BA AP3
								964				T				
								965				T				
								966			T					
								967			T					
								968			T					
								969		T						
201					T											Run J 1A3
202					T											
204					T											
205					T											
206					T											
207						T										
208						T										
209							T									

SET 12 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES
																Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								603						T		Run N-1A5
								604							T	
								605							T	
214		T														Run S-1A5
215		T														
216		T														
217		T														
218		T														
219		T														
220			T													
221			T													
222			T													
223			T													
224			T													

SET 13																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								601					T			Run F 1A6
								602					T			
								603					T			
								604					T			
								605					T			
								606					T			
								607					T			
								608					T			
								609					T			
								610					T			
								611					T			
								612					T			
								613					T			
								614					T			

SET 14																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
224	T															Run B-1A4
225	T															
226	T															
227	T															
228	T															
229		T														
230		T														
231		T														
232		T														
233		T														
234		T														
235			T													
236			T													
237			T													
238				T												
248		T														Run D-1 A3
249		T														
250		T														
251		T														
252		T														
253		T														
254		T														
255		T														
256		T														
257		T														
258		T														
259		T														
260	T															
268				T												Run E 6A1

SET 14 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES: Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
269				T												Run E - 6A1
270				T												
271				T												
272				T												
273				T												
274				T												
275				T												
276					T											
277					T											
278					T											
279					T											

SET 15

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
202				T												Run R 1A3
203				T												
204				T												
205				T												
206				T												
207				T												
208				T												
209				T												
210				T												
								631			T					Run R 1A6
								632			T					
								633			T					
								634			T					
								635			T					
								636		T						
								637		T						
439						T										Run I 1A5
440						T										
441						T										
442							T									
443							T									
230					T											Run D 1A4
231					T											
232					T											
233					T											
234					T											
235					T											
236						T										
237						T										

SET 15 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES
																Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
238					T											Run D–1A4
239					T											
240						T										
241						T										
242						T										
243						T										
219				T												Run R–1A5
220				T												
221					T											
222					T											
223					T											
224						T										

SET 16																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
801	T	T														Run NA AP3
802	T															
803	T															
804	T															
805	T															
806	T	T														
807	T	T														
808	T	T														
809		T														
810	T	T														
811		T														
812		T														
813			T													
814			T													
815			T													
816			T													
817			T	T												
818			T	T												
819			T		T											
820			T			T										
821			T			T										
822			T			T										
823			T				T									
824			T				T									
825			T													
826			T													
827		T														
828					T											Run NA AP4
829					T											

SET 16 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
830					T											Run NA-AP4
831					T											
832					T											
833					T											
834			T	T	T											
835			T	T	T											
836			T	T	T											
837			T	T	T											
838			T	T	T											
839			T	T	T											
840			T	T		T										
841			T	T		T										
842			T	T		T										
843			T	T		T										
844				T												
845				T												
846				T												Run NA-AP5
847					T	T										
848					T	T										
849					T	T										
850					T	T										
851					T	T										
852					T	T										
853					T	T										
854					T	T										
855					T	T										
856					T	T										
857					T	T										
858					T	T										

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
859					T	T										Run NA-AP5
860					T	T										
861				T		T										
862				T		T										
								901			T					Run BA-AP4
								902			T					
								903			T					
								904			T					
								905			T					
								906		T						
								907		T						
								908		T						
								909	T							
								910	T							
								911	T							
								912	T							
								913		T						
								914		T						
								915		T						
								916		T	T					
								917			T					
								918					T			
873					T											MI-AP1
874					T											
875					T	T										
876					T											
877					T											
878					T	T										
879				T		T										

SET 16 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
880		T				T										MI AP1
881	T					T										
882						T										
883						T										
884						T										
885						T										
886					T											
887					T											
888					T											
889					T											
								965				T				Ph AP2
								966				T				
								967					T			
								968						T		

SET 17																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								904	T							NE AP1
								905	T							
								906	T							
								907	T							
								908	T							
								909	T							
								911						T		

SET 18

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								628		T						Run A 2A2
								629		T						
								230		T						
								631		T						
								632		T						
								633		T						
								634		T						
								635		T						
								636		T						
								637		T						
								638		T						
								639		T						
								640		T						
								641		T						
								642		T						
								643			T					
								644			T					
								645			T					
								646			T					
								647			T					
								648			T					
								650				T				
								651				T				
								652				T				
								653					T			
								654					T			
								655								
								[illegible]						T		
								657						T		

SET 18 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								658							T	Run A-2A2

SET 19																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								644		T						Run J-1A5
								645		T						
								646		T						
								647		T						
								648	T							
								649	T							
								636				T				Run G-2A1
								637				T				
								638				T				
								639				T				
								640				T				
								641					T			
								642					T			
254						T										Run K-1A8
255						T										
256							T									
257							T									
258							T									
235			T													G-1A4
236			T/T													
237			T/T													
238		T	T													
239			T													
240		T														
241		T														
242		T														
								039	T							
								040	T							
								041		T						

SET 19 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								042		T						Run G 1A4
								043			T					
244			T													Run N 1A8
245						T										
246						T										
247						T										
226				T												Run B 7A3
227				T												
228				T												
229				T												
231			T													
								611					T			Run C 1A5
								612					T			
								613					T			
								614					T			
								615					T			
								616					T			
								617					T			
								618					T			
								619					T			
								620					T			
								621					T			
								623							T	
								624							T	
								625							T	
								626							T	
								627							T	
								628							T	
								629							T	

SET 19 (Cont'd)

Mask No	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES
																Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								630							T	Run C 1A5
								631							T	

SET 20

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
219				T												Run R 1A7
223				T												
224				T												
225			T													
226			T													
227		T														
								624					T			Run E 1A3
								625					T			
								626					T			
								627					T			
								628					T			
								629					T			
								630					T			
								631					T			
								632					T			
								633					T			
								634					T			
								635					T			
								636					T			
								637						T		
								645		T						Run R 1A8
								646		T						
								647		T						
								648		T						
								649		T						
								650		T						
								651			T					
								652			T					
								653			T					

SET 20 (Cont'd)

Mask No	3	4	7	6	5	2	1	Mask No	1	2	5	6	7	4	3	NOTES
																Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								654			T					Run R 1A8
								655		T						↓
								656		T						Run S 1A3
								657		T						
								658		T						↓
465				T												Run S 2A2
466				T												
467			T													
468		T														
469	T			T												↓
228				T												Run R 4A3
229				T												
230				T												
231				T												
232				T												
233				T												
234				T												
235			T													
236			T													
237	T															↓

SET 21

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								901		T						OC - AP1
								902		T						
								903	T							
								904	T							
802					T											
803					T											OC - AP2
804					T											
805					T											
806					T											
807						T										
808						T										
809							T									
810							T									
811							T									
812							T									
813							T									
814							T									
815							T									
816							T									
817							T									
818							T									
819							T									
820							T									
821							T									
822							T									
823							T									
824							T									
825							T									
840				T												MI - AP2

SET 21 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
841					T											MI · AP2
842					T											
843					T											
844					T											
845					T											
846					T											
847					.											
848						T										
849						T										
867				T												MI · AP3
868				T												
869				T												
870				T												
871				T												
872					T											
873					T											
874					T											
875					T											
876					T											
877						T										
878						T										
879						T										
880						T										
881						T										
401		T														Run · H 1A9
402		T														
403		T														
404		T														
405			T													

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	SET 21 (Cont'd) NOTES Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
406			T													Run H-1A9
								601				T				
								602				T				
								603				T				
								604				T				
								605				T				
								606				T				
								607			T	T				
								608			T	T				
								609			T	T				
								609*		T		T				
204				T												Run K 1A10
205				T												
206				T												
207				T												
208				T												
209				T												
215				T												Run M 1A4
216		T														
								939				T				Run 3A AP5
								940					T			
								941					T			
								942					T			
								943					T			
								944					T			
								945				T				
								946				T				
								947			T					
								948			T					

SET 21 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								949			T					Run BA-AP5
								950		T						
								951		T						
								952		T						
								953		T						
								954		T						
								955	T							
								956	T							
								957	T				T			
								958	T					T		
								959	T						T	

SET 22

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES: Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
218							T									Run A-2A3
219							T									
220							T									
221							T									
222							T									
223							T									
224							T									
225							T									
226							T									
227							T									
228							T									
229							T									
230							T									
231						T										
232						T										
233						T										
234						T										
235					T											
236					T											
237					T											
238				T												
239				T												
240			T													
241			T													
242		T														
243		T														
244	T															
245	T															
246	T															

SET 22 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
249				T												Run E 1A4
250				T												
251				T												
252				T												
253				T												
254				T												
255				T												
256				T												
257				T												
258				T												
259				T												
260				T												
261				T												
262				T												
263				T												
264				T												
265				T												
268						T										
269						T										Run N 1A10
270						T										
271					T											
								604	T							Run N 1A11
								605	T							
								506	T							
								607		T						
								612				T				Run Q 4A3
								613					T			
								614							T	
278					T											Run Q 4A4

SET 22 (Cont'd)

Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	NOTES: Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
279		T														Run Q-4A4
419			T													Run D-1A5
420			T													
421			T													
422			T													
423			T													
424			T													
425			T													
426			T													
427			T													
428			T													
429				T												
430				T												
431				T												
432				T												
433					T											
434					T											
435					T											
								617		T						
								618		T						
								621						T		
								622						T		
								623						T		
								624						T		
								625						T		
								626						T		
								627						T		
								628						T		
								629						T		

SET 22 (Cont'd)																NOTES
Mask No.	3	4	7	6	5	2	1	Mask No.	1	2	5	6	7	4	3	Camera Number
	1	2	3	4	5	6	7		8	9	10	11	12	13	14	Panel Number
								630						T		Run D–1A5
								631						T		
								632						T		
								633						T		
								634						T		
								635						T		

MAINTENANCE PROCEDURES

I. PREVENTIVE MAINTENANCE

A. GAT-1

On a monthly basis the GAT-1 should be checked using the GAT-1 calibration test procedures presented in Section X, Part VI. This should be done by qualified personnel. The Operations and Maintenance Manual put out by the manufacturer can be used as an additional reference for mechanical checks.

B. PDP-8E COMPUTER AND ACCESSORIES

Preventive maintenance will be performed monthly by the Electronic Services Division of NAMRL. This maintenance will include analysis of the PDP-8/e digital computer, the A/D converter (ADOI-AP), the paper tape reader (DR8-EA), and the teletype (ASR-33). Calibration procedures and documentation for the A/D converter are presented in Section VI, Part IV. The manufacturer's literature must be used for the other equipment.

C. PROJECTION SUBSYSTEM

Performance checks of the projection subsystem done on a routine basis by personnel in the Vision Division should identify any problems in the subsystem. Any necessary repair of the remote control box or electrical relay junction box in the projection booth will be done by the Electronic Services Division of NAMRL. Mechanical and electrical repair of the Kodak equipment will be performed by Naval Training Aids of the Naval Air Station, Pensacola.

D. PROJECTION SCREENS

The Kodak Ektalite projection screen has an aluminum surface which is quite delicate. The prevention of dirt accumulation on the screen is of paramount importance since images projected on the screen can be degraded in quality. The screen should be dusted, weekly, with a feather or camel hair brush.

To remove fingerprints and light surface dirt, the following procedure should be used. [Fingerprints should be removed immediately, as they will eventually etch the foil.]

Step 1. Remove any surface dust from the area to be cleaned by brushing lightly with a camel's hair brush.
Step 2. Pour some TSP powder into a pail.
Step 3. Adjust enough hot water to dissolve it entirely.
Step 4. Wipe area about one foot square with cotton or a soft cloth. Always wipe with the grain of the screen. DO NOT RUB

Step 5. Immediately afterwards, wipe the area with a soft paper towel saturated in plain hot water.

Step 6. Immediately wipe the area with toilet or facial tissue to dry it and prevent water spotting.

II. PERFORMANCE TESTS

Four major tests of the VDS system should be performed after any maintenance work or repair and on a regular basis during data collection. These tests would assure that the system is functioning properly for experimental runs. The four tests are presented below.

1. I/O Digital Input

This subsystem should be tested first. The procedure for this check is presented in Section V, Part III, Computer Check of the Digital I/O Signals. Use the I/O Digital Interface Check-out procedures so that both the computer I/O cards and the controls on the Supervisor's Console can be checked. Be sure the ON/OFF switch on the Supervisor's Console is in the ON position. This enables the necessary power supplies for the junction box and digital controls. If a problem is detected the M863 check-out test should be done to determine whether the problem is on the I/O board or the external circuitry within the Supervisor's Console/ Junction Box.

2. Analog Signals

These signals should be tested second. The best method for checking these signals is to use the computer program. With this method, the calculations of the analog signals will indicate what signals are not within acceptable limits. Procedures for this test are presented in Section VI, Part VI, Calibration Check with the Computer Program. If a problem is detected, the appropriate circuit board in the GAT-1 should be checked and the PDP-8/e A/D Converter tested. Procedures for testing the A/D Converter are presented in Section VI, Part IV. The GAT-1 manuals contain the information pertaining to the circuit boards.

3. GAT-1

The GAT-1 flight characteristics should be checked for general responsiveness to the pilot controls. The flight check given in Section X, Part VI, should be used for this assessment. If the navigational system is used for experimental runs, these systems also need to be evaluated. Follow the procedures for VOR and magnetic deviation programming check, ILS programming check, and ADF programming check found in Section IX, Part III. For a problem with the navigational system, first check the programming then the appropriate pots on the Navigational Area Programming Panels. If the problem cannot be located, the GAT 1 circuit boards must be checked.

4. PROJECTION SYSTEM

The projection subsystem can be tested by running the computer program with the short tape version of an experimental run. Check to see if the dissolve units are switching between the odd and even projectors and if both the right and left hand side are synchronized. Should only one or two units not function properly, replace the appropriate dissolve unit or projector. If the entire projection system does not work properly under computer control, the hand held remote control box should be used to isolate the problem. If the projection subsystem can be controlled by the hand held controller, it would indicate a problem with the computer or junction box in the Supervisor's Console. If the hand held controller does not activate the projection subsystem, the problem would probably be in either the projection booth junction box, the + 24 volt power supply, or the wire connections between the Supervisor's Junction Box and the Junction Box in the projection booth.

While the projectors are operating, they should be checked for unusual noises, misalignment, and to see if the slides are dropping into the slide gate properly. If the projectors are not operating properly, turn the malfunctioning unit in to Naval Training Aids for repair. Put all the slide trays which are used for an experiment on their respective projectors. With the projectors ON, press the select button on the side of the projector. Slowly spin the trays. If a tray does not readily turn, check the bottom of the slides to see if one is chipped. Repair the slide or discard it. Also check the plastic foot in the projector gate which pushes the slides into the tray. If the foot is not smooth, it will catch on the slide and not properly position the slide back into the tray. A piece of emery cloth will typically correct this problem if the foot has not been severely damaged by a broken slide. Occasionally, the tray itself does not function properly. This can be checked by putting the tray on a good projector and test the tray by manually advancing and reversing it.

OPERATIONAL PROCEDURES

Prior to placing a subject in the VDS for experimental purposes, it is necessary to have the computer program loaded and the projection system prepared for operation. The projection system preparation is presented in Appendix C, while instruction for loading the program can be found in Appendix D, Part II. In addition, the projection, GAT-1, and computer subsystems should be checked to insure that all equipment is functioning properly. Appendix B describes in detail how these checks should be performed.

Step-by-step procedures for making an experimental run under the current configuration is presented below.

Step 1. Before the subject arrives, the supervisor selects the appropriate scenario for the experiment. A scenario consists of 28 coded slide trays for the 14 projector-pairs which illuminate the 14 contiguous screen sectors. Each tray contains up to 140 slides. The supervisor selects the computer tape which contains the appropriate identification of the targets and places the associated 28 slide trays in the proper projectors.

Step 2. When the subject arrives, he and the supervisor prepare a flight plan to be followed during the experiment. This plan specifies airspeeds, altitudes, and VOR-radials or headings to be flown.

Step 3. The supervisor then enters pre-run data into the computer using the Teletype and the fast Paper Tape Reader. These data include the subject's name and all constant parameters needed for the experimental run. The data are not directly related to the slide material and are read into the computer before the run starts. Specific instructions on how to operate the computer are described in Appendix D, Part I.

Step 4. The supervisor then places an appropriate scenario tape in the fast Paper Tape Reader. The computer reads the data for the first slide without advancing the projector. At this point the computer stops and waits for a START input from the Supervisor's Console.

Step 5. Before starting the experiment, the supervisor monitors the pilot's performance as he takes the GAT-1 to an assigned position, altitude, airspeed, and heading or VOR radial. These "command" parameters are set on the Supervisor's Console controls and monitored by the computer.

Step 6. When the subject has flown the GAT-1 to a position called for in the flight plan, the supervisor depresses the START button to begin the visual display and the experiment. The computer immediately controls all odd projections to show the first slide in the scenario sequence if all even projectors were on before the experiment started.

Step 7. During the entire experiment, the computer generates slide change and slide advance signals at regular intervals. Each SL ADV signal switches all OFF projectors (either "even" or "odd" set) to ON, switches all ON projectors to OFF, and advances the new OFF set of projectors by one slide position. To skip slides, the computer sends SKIP signals immediately following a SL ADV signal.

Step 8. Prior to each slide change the computer reads-in a block of scenario data containing the following information.

1. Slide number.
2. The number of aircraft which are visible on the screen.
3. The number of (0 to 3) ODD slides to SKIP.
4. The number of (0 to 3) EVEN slides to SKIP.
5. Discontinue SLIDE ADV for either the right or left 90° half of the visual field.
6. Assigned target numbers for aircraft which first appear on next slide.
7. Direction of all targets to nearest 2°.

Step 9. Throughout the experiment, the computer compares command flight parameters with actual real-time samples from the GAT-1. A figure-of-merit on the quality of piloting is calculated every 5 seconds.

Step 10. When the subject pilot visually detects an aircraft, he depresses the Detect Button and the time of detection is recorded in the computer. The subject also announces the detect sector (1 to 14) and the supervisor depresses the corresponding button. Internally, the computer matches the indicated sector with target numbers and positions to determine accuracy.

Step 11. As the experiment progresses, the supervisor monitors flight conditions and the flight plan to keep reference "command" flight parameters up-to-date. If required by the experimental design, he also changes the flight condition when necessary.

Step 12. If at any time the supervisor wishes to halt or interrupt the experiment, he may do so by depressing the STOP button. This suspends all computer operations in the last state and preserves everything necessary to resume operation on the next instruction with no skipped instructions. Depressing the CONTINUE button resumes the experiment. The instructor might, for example, use the STOP to modify a flight plan if the pilot appears to have too much difficulty.

Step 13. At the end of the experiment, the computer calculates a number of statistical measures of real-time figure-of-merit results. These data and a record of all detections are printed out by the teletype.

Step 14. At the conclusion of the experiment, the subject participates in a debriefing with the supervisor.

APPENDIX A

POWER UP AND SHUTDOWN PROCEDURES

I. GAT-1

A. TURN ON PROCEDURES

1. GAT-1 POWER ON

Step 1. Roll, Pitch, and Yaw motion switches OFF.
Step 2. Turn key ON.
Step 3. Push red power button. The tire screech must be audible when the trainer is turned on. If not, quickly turn power OFF and notify proper personnel

2. ENGINE ON

Step 1. Insure that the parking brake is ON (aft position).
Step 2. See that the CARB HEAT control is OFF (forward position).
Step 3. Crack the throttle (push forward slightly).
Step 4. Turn the MASTER switch to ON.
Step 5. Set the MIXTURE control to its full rich position (forward position).
Step 6. Start the engine by setting the IGNITION control to the START position momentarily and returning it to the BOTH position. The tachometer should indicate 550 (± 30) rpm.

3. PRE-FLIGHT CHECK

Step 1. Check OIL PRESSURE, OIL TEMPERATURE, CYLINDER HEAD TEMPATURE, and FUEL gauges to insure that all needles are in the green regions. If not, adjust the controls on the Supervisor's Console.
Step 2. Set the altimeter pressure reading to 30.00 by adjusting the knurled knob on the indicator.
Step 3. The altimeter should read zero feet. If not, adjust the FIELD ELEVATION control on the Supervisor's Console.
Step 4. Insure that the CENTER OF GRAVITY control on the Supervisor's Console is set to 25 percent, GROSS WEIGHT to 1600 lbs., OUTSIDE AIR TEMPERATURE is set to standard, WIND VELOCITY is set at 0 knots (turned fully couterclockwise), and the ROUGH AIR is OFF.
Step 5. If the X-Y recorder is to be used, place the ON/OFF switches ON and turn the mode switch to norm.

Note: For takeoff procedure, refer to GAT-1 Flight Check, Part A, Section X. Energize the pitch, roll, and yaw motion switches for flight.

B. GAT 1 SHUTDOWN PROCEDURES

1. PILOT INSTRUMENT PANEL

Step 1. Pull PARKING BRAKE aft.
Step 2. Adjust the throttle to idle.
Step 3. Set the MIXTURE control to full lean.
Step 4. Set the IGNITION switch to OFF.
Step 5. Set the MASTER switch to OFF.

2. RECORDER CONTROL PANEL

Step 1. At the recorder control panel, turn the MODE switch to the zero position.
Step 2. Place the ON/OFF switch to the OFF position.

3. POWER PANEL

Step 1. Deactivate the three motion switches. Always deactivate these switches before turning power OFF.
Step 2. Depress the POWER button to OFF.
Step 3. Turn the key-lock switch OFF.

II. COMPUTER

A. TURN ON PROCEDURES

Step 1. Turn the key located on the computer console to the POWER position. (If the key is turned to the PANEL LOCK position, no input can be made to the computer from the console. PANEL LOCK should only be used when all the computer tapes have been loaded and the experimental run is ready to start. This key position prevents any accidental input to the computer during the experiment which might alter or stop the program.)
Step 2. Turn the teletype (TTY) switch located on the lower right-hand edge to LINE. (This links the TTY and computer together so that the computer can accept input from the TTY. The switch position LOCAL allows the TTY to be used on a stand alone basis without the computer.)
Step 3. Insure that the TTY paper tape reader switch is set to FREE and the TTY paper tape punch is OFF. The paper tape punch and reader are located on the side of the TTY.
Step 4. Insure that the toggle switch of the highspeed paper tape reader (PTR) above the console is in the ON position.
Step 5. Insure that the HALT switch on the computer console is up.

B. SHUTDOWN PROCEDURES

Step 1. Turn the TTY paper tape reader switch to FREE and depress the TTY paper tape punch OFF button.
Step 2. Turn the TTY switch to the OFF position.
Step 3. If the run light is on, press the HALT switch on the computer console.
Step 4. Turn the key located on the computer console to the OFF position.

III. PROJECTION SYSTEM

The power switch to the slide projectors is an ON/OFF toggle switch located on the Supervisor's Console. If there are resolution slides in the projector's gate, do not turn on projector power unless the slide trays are properly positioned on the projectors.

IV. JUNCTION BOX

The power switch for the 5 VDC and 15 VDC power supplies to the junction box is an ON/OFF toggle switch located on the Supervisor's Console. This Switch should be placed in the ON position during an experimental run.

APPENDIX B

OPERATIONAL CHECK

The quickest and easiest method for insuring that the VDS system is functioning properly is to run the VDS computer program and the I/O Digital Interface Check-out program. While this method is not all-inclusive for testing the entire system, the digital I/O and analog signals necessary for calculating the performance measures can be checked for general malfunctions. It is believed that this method would be adequate as a daily operational test. More extensive testing should be done on a weekly basis. The procedures for the weekly performance tests are presented in Section XII, Maintenance Procedures. The procedures for the daily operational check are presented below.

Step 1. Turn on the computer, projectors, power supplies to the Junction Box, and the GAT-1.

Step 2. To check the analog input and the performance calculation, turn the GAT-1 engine on. See Appendix A.

Step 3. In the GAT, push the throttle and air mixture controls fully. Release the parking brake (push in the control). This procedure enables the airspeed to increase from zero which is necessary for rudder control of the yaw motion system.

Step 4. Energize the yaw motion system.

Step 5. Set the Direction Gyro Indicator to read South by using the rudder pedals. Turn the yaw motion switch off.

Step 6. Adjust the throttle until an airspeed indication of 100 MPH is obtained. Be sure the motion switches are off.

Step 7. Turn the field elevation pot on the Supervisor's Console until a 3,000 feet indication is obtained on the altimeter.

Step 8. Set the parameter switches on the Supervisor's Console to LEVEL, VFR, ALTITUDE O/O, DG, COMPUTE, AIRSPEED 95 MPH, and 000 HEADING.

Step 9. Run the short version of the VDS computer program. [A modified version of the parameter and scenario tapes has been made which shortens a computer-run to approximately one minute. On the parameter tape, the time interval at which slides are changed is set to 5 seconds, and on the scenario tape, the number of slides in a scenario is set to 10. Instructions on how to operate the computer and to load the program are described in Appendix D.]

Step 10. Check the analog calibrations on the printout. [Multiply the peak deviation in the fifth column by the unit value descrived in Appendix E, Data Output on TTY. The derived scores should be equivalent to the differences in the instrument readings and parameter settings.]

Step 11. Rerun the program, and monitor the slide changes made by the projectors.

Step 12. Return the field elevation pot to its original setting so that the altimeter in the GAT-1 reads zero feet.

Step 13. To check the digital input, run the I/O Digital Interface Check-out program. The procedures are presented in Section V, Computer Check of the Digital I/O Signals, Part III. Before running the program, set 7777_8 in the switch register. Pull up on the DEP switch. While the switch is up, check to see that all lights in the accumulator are on. Release the DEP switch. Proceed with the procedures required by the computer.

Step 14. Relod the VDS program.

Step 15. Shut down the systems.

APPENDIX C

PROJECTION SYSTEM PREPARATION

Each screen sector is illuminated by two projectors. The projector on the right has been labeled EVEN and the projector on the left has been labeled ODD. Therefore, there is an odd and even projector for each of the contiguous screen sectors. A scenario consists of 28 slide trays, one per projector. To load a scenario, each tray will need to be placed on the appropriate projector. Each tray is labeled odd or even and according to its sector number. The projectors are marked in the same manner. For every pair of projectors, there is a dissolve control unit which is located underneath the projectors. The following information tells how the projection system should be prepared for VDS operation.

Step 1. Insure that all dissolve units are plugged into the wall outlets and the computer remote cord is connected.

Step 2. All dissolve units should be toggled to ON and the timing control on MANUAL.

Step 3. Plug the projector remote cords to the odd and even projectors. The bottom remote cord should be plugged into the even projector.

Step 4. The projector's lamp setting should be on FAN.

Step 5. Turn on the projector power by using the switch at the Supervisor's Console.

Step 6. Check to see that only the even projectors are on. If one pair is reversed, change the timing control of the dedicated dissolve unit to 6 seconds. The dissolve control will switch to the opposite unit. Put the setting back to MANUAL. If any projectors do not come on, check to see that the dissolve unit and projectors are plugged into the appropriate outlets and that the units are turned on. Also determine if a projector lamp needs to be replaced.

Step 7. Visually check the color of the projected light. If there is any color tint, replace the light bulb.

Step 8. Place a resolution slide in the empty gate of each projector and then place the slide trays on the projectors. To insure that the trays are properly seated press the SELECT button. Make sure the projectors are on the 0 slide slot.

Step 9. By using the resolution slide, make sure the projected images are aligned and in focus for the 14 ON projectors. Focussing is very critical for the VDS system. It is imperative that any image used for focus be at the center of the screen. Due to the curvature of the screen and the high, angular position of the film plane, any image brought into clear focus on the top panel will be blurred in the bottom panel. Therefore, obtaining the best possible focus at the horizontal joint of the screen is the best compromise. Be as systematic as possible in judgements concerning focus; otherwise, subject differences found in an experiment may be due to focus differences rather than true performance differences.

Step 10. After checking the 14 ON projectors, put the projector lamp setting on OFF.

Step 11. Set the remaining 14 projectors to the HIGH lamp setting which overrides the dissolve control. Replace light bulbs if necessary. Check the color of the projected light. Align and focus.

Step 12. Set all projectors back to the FAN lamp setting. Insure that all projectors are on the 0 slide slot.

APPENDIX D

COMPUTER PROCEDURES

I. INSTRUCTIONS FOR COMPUTER OPERATION

To run an experiment, information to the computer must be entered through the teletype (TTY) and the high-speed paper tape reader (PTR). The TTY parameter input is punched on an individual short paper tape for each scenario. These tapes, which are called the "parameter tapes," are read in through the TTY paper tape reader located on the left side of the TTY. Data relevant to the scenario of slides are read by the PTR. These data include the number of targets in the scenario, the identification number of each target, the angular position of the target relative to the GAT-1, and the sequencing of the right and left half of the projected field-of-view. These data are punched on a fan-folded paper tape that is called the "scenario tape." Throughout an experimental run, short segments of the scenario tape are automatically read-in prior to each slide change. The following outline is a step-by-step procedure of the computer operations required for an experimental run.

Step 1. Turn on the computer, projectors, power supplies to the junction box, and the GAT-1. The power ON procedures are presented in Appendix A.

Step 2. Select the desired scenario tape and place it in the PTR (high-speed paper tape reader) located above the computer console. Be sure the PTR is turned ON.

Step 3. Turn the TTY (teletype) switch to LOCAL, the TTY paper tape reader switch to FREE, and depress the TTY paper tape punch button marked ON. The paper tape punch and reader are located on the left side of the TTY. Make sure there is plenty of tape for the TTY paper tape punch and for the keyboard. Press the HERE IS button on TTY keyboard. This will cause the TTY to produce a short piece of blank tape. Press the HERE IS key several times. [NOTE: The purpose of the last step is to prepare a leader for the paper tape which will contain all initial information regarding the experimental run and the subject's data. The information will automatically be punched on the tape during the remainder of the procedure.] Now, turn the TTY switch to LINE, and place the parameter tape into the TTY tape reader.

Step 4. Depress all the keys of the switch register (SR) on the computer console down. Now, lift keys 8 and 11 of the SR (0011_8) and depress EXTD ADDR LOAD key. Again, depress all SR keys. Now, lift keys 2, 3 and 10 (1402_8). Depress ADDR LOAD key, then START/CLEAR, and then START/CONT key. The teletype keyboard should jump once.

Step 5 Type in the subject number (4 digits mandatory) on the TTY keyboard. Press the RETURN key. Depress the OFF button on the paper tape punch. Set the TTY tape reader switch to START, and it will read in the parameter tape, type the information contained on the tape on the keyboard, and punch it on the TTY tape punch. If this does not happen, the punch has not been turned on properly, or the tape has been jammed. At the end of the tape, the input will be echoed once more on the TTY; check for errors. During this time, the PTR will also read a short segment of the scenario tape. Now switch the TTY tape reader to FREE and remove the parameter tape. Depress the TTY paper tape punch button marked ON.

Step 6. Check to see if the clock on the supervisor's console is stopped. If it is not, push the STOP button on the supervisor's console. If everything appears normal and the subject is already to begin, push the START button. This should reset the clock to 0. Now, press the CONTINUE button on the console. Slides will change, the clock will start, and data collection will be underway. If the computer does not respond correctly, go back to Step 3 and proceed again. If the computer still does not respond, it may be necessary to reload the program as described in Part II. Should reloading not help, corrective maintenance may be required.

Step 7. If a mistake is made during any of the above steps, depress the HALT key on the computer, lift it up again and go back to Step 3. Do the same if an error message is typed out on the TTY. When there is an error message, more than likely the tape in the PTR was not positioned over the blank part of the tape, but over some punched part of the tape. Also check to see if the subject's identification number was correctly typed in. If the error message persists, select another scenario tape. There should be more than one copy of each scenario tape.

Step 8. During an experimental run, it is possible to halt the data collection and slide changes by depressing the STOP button on the Supervisor's Console. To proceed with the experiment, just push the CONTINUE button located on the same panel. Follow this procedure only when the subject must correct his flight errors or when required by the experimental design. Caution should be exercised, since all the subjects need to be exposed to the same experimental procedures for meaningful analysis.

Step 9. At the end of the experiment, the data output will be typed out on the TTY and punched out on the TTY tape punch. See Appendix E for a description of the data output. At the conclusion of the data output, turn the TTY switch to LOCAL and depress the HERE IS key on the TTY keyboard until this produces blank tape. Rip off the tape and mark it with the subject's identification number, experiment identification code, and date. Press the OFF button on the TTY tape punch. This tape is to be transferred to the Hewlett Packard System. The procedures are presented in Section IV, Part IX.

Step 10. Leaving the PTR on, turn off the TTY, the computer, and GAT-1, in that order. Power down procedures are presented in Appendix A. Remove the trays from the projectors and then turn off the projection system by the switch on the Supervisor's Console.

II. INSTRUCTIONS FOR PROGRAM RELOADING

Step 1. Turn the computer ON. Power ON procedures are presented in Appendix A. Be sure the TTY (teletype) switch is turned to LINE and the PTR (high-speed paper tape reader) is turned ON.

Step 2. Check whether the Binary Loader is in core. Press all SR switches down. Lift up switches 7, 8, 10, and 11 (0033_8), press EXTR ADDR LOAD. Lift all SR switches (7777_8), press ADDR load. Turn EXAM ROTATE selector switch to MD. Do the lights show 5301? If yes proceed with Step 4 (the Binary Loader is in core). Otherwise, go to Step 3. (A more complete check to determine if Binary is in core is to start Binary with no tape in the PTR reader. Set SR switches to 33_8, press ADDR LOAD. Set SR to 7777_8, press ADDR LOAD, the push HERE IS key on the TTY and then simultaneously depress the control and K keys on the TTY while the HERE IS key is functioning. If binary is in core, the computer will halt i.e. the run light will go off.)

Step 3. Check whether the RIM Loader is in core. Use procedures specified in Figure 5-2 on page 5-4 of DEC's "Introduction to Programming" (set switches 6-8 and 9-11 equal to 33_8). The instructions are listed in Table 5-1, Appendix E; use the set of instructions for the high-speed reader. Load the Binary Loader by using the procedure specified in Figure 5-3, set switches 6-8 and 9-11 equal to 33_8, use high-speed reader.

Step 4. Load the Linking Loader. Set switches 6-8 and 9-11 equal to 33_8 and press EXTD ADDR LOAD. Set SR equal to 7777_8, press ADDR LOAD. Place Linking Loader tape in high-speed reader. Set SR equal to 3777_8. Press CLEAR and CONTINUE. The Linking Loader should now read in. Proceed with Step 5.

Step 5. To load final programs used for the VDS experiments. Set switches 6-8 and 9-11 equal to 33_8. Press EXTD ADDR LOAD. Set SR equal to 0200_8. Press ADDR LOAD.

Step 6. Take first tape in Table D-1, put it in the high-speed reader. Set switches 9-11 equal to the field setting in Table D-1. [Lift up switch 11 for field 1, switch 10 for field 2, and switch 9 for field 3.] Press CLEAR and CONTINUE. Tape should read-in. If teletype types out "Error 5," tape was not advanced far enough to reach the set of holes along one side of the tape, reposition tape, and press CONTINUE again. For "Error 2," go back to Step 4.

Step 7. Take next tape in Table D-1, place it in the high-speed reader. Set switches 9-11 equal to the field setting. Press CONTINUE. Tape should read in.

Step 8. Repeat Step 7 until all tapes in table D-1 have been read in. Then set SR equal to 2000 and press CONTINUE. A long list of items will be typed out. Look for MAIN followed by a five digit number; make sure it is 11403, otherwise the programs were not loaded according to Table D-1. Also look for any U's on the right following any of the five digit numbers. If a U appears, you forgot to load that program, go back to Step 4. If everything checks out the programs have now been reloaded.

TABLE D-I

Program Name	Date Last Revised	Field Setting
VDS. Assembled (Main Program)	1/22/74	1
QUEST. 15	6/14/73	0
SLIDE. Assembled	5/18/73	0
AURAL. Assembled	4/13/73	0
SCTR. Assembled	6/14/73	0
TIMER. Assembled	1/22/74	0
HDUP. Assembled	6/04/73	0
XANGL. Assembled	6/14/73	0
XX. Assembled	6/14/73	1
DECOD. Assembled	1/22/74	1
MERIT. Assembled	1/22/74	2
REF. Assembled	1/31/74	2
DEC FORTRAN LIBRARY*, PART 1, Program 1		3
PART 1, Program 2		3
PART 1, Program 3		1
PART 1, Program 4		2
PART 1, Program 5		1
PART 2, Program 1		3

* Several of the programs are punched together on the same tape. The computer will stop after each program.

APPENDIX E

DATA OUTPUT ON TTY

I. FIGURE-OF-MERIT DATA

The figure-of-merit data consist of 40 rows and 5 columns. The first column contains an integer from 1 to 8, which indicates the detection state and altitude rate for the calculations.

1) Not used.
2) Not used.
3) No detected targets; level flight.
4) Targets have been detected; level flight.
5) Not used.
6) Not used.
7) Same as 3, but climb/descend.
8) Same as 4, but climb/descend.

The second column contains an integer from 1 to 5 and indicates the type of flight performance quantity:

1) Altitude rate.
2) Altitude.
3) Airspeed.
4) Heading.
5) VOR deviation.

The third column shows the number of terms in the sum of squares. The fourth column shows the sum of squares of deviations; the fifth column shows peak deviation. The units are: 1) for altitude rate one unit is 24.4 ft./min.; 2) for altitude one unit is 13 ft.; 3) for airspeed one unit is 0.935 knot; 4) for heading one unit is 1°; 5) for VOR deviation one unit is a deviation of 0.0976°.

For some combinations of columns there will be no entries because the combination cannot occur; e.g., altitude deviation is not calculated during climb/descent. Space was still allowed for such impossible entries because it required less computer memory to accommodate such entries than to check and bypass them.

II. DETECTION DATA

The detection data consists of 3 columns.

The first column shows the target number. A -1 will appear if: a) there was no target within 20° of the centerline of the indicated screen panel; b) the screen panel button was not yet pressed TSUP seconds after the detection button had been pressed; c) the error button was pressed instead of the screen panel button.

The second column shows the screen panel number for the detected target, usually an integer from 1 to 14. A 100 will be added to this number if the taget was out of the normal field of view ($\pm 88^{o}$) because of yaw. A -1 will appear if the screen panel button was not pressed TSUP seconds after detection. A -2 will appear if the error button was pressed.

The third column shows the time in seconds at which the detection button was pressed.